DEVELOPMENT OF SEDIMENT QUALITY GUIDELINES
PHASE II - GUIDELINE DEVELOPMENT

Final Report to:

Ontario Ministry of the Environment
Toronto, Ontario

Prepared by:

Donald R. Hart, Ph.D., Jerry Fitchko, Ph.D.
and Paul M. McKee, M.Sc.

BEAK CONSULTANTS LIMITED
14 Abacus Road
Brampton, Ontario
L6T 5B7

September 1988
BEAK Ref. 2437.1

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1.0 INTRODUCTION

Sediments are the principal reservoir or sink for persistent toxic chemicals in aquatic systems. An increasing emphasis on studies of the distribution, geochemistry and biological effects of persistent toxic substances in sediments of the Great Lakes basin has occurred since 1970, when mercury contamination of sediments and fish in Lake St. Clair was publicized and became a matter of disquiet at both public and governmental levels. However, there is not yet a consensus on methods of interpreting such data in order to evaluate sediment quality and characterize toxic substance problems on a consistent basis.

A number of protocols for sediment quality evaluation have been developed over the previous ten to 15 years in North America, primarily in response to concerns over toxic substances in dredge spoils. Beak Consultants Limited (BEAK) reviewed these and other more recent protocols during Phase I of this study (BEAK, 1987) for the Ontario Ministry of the Environment (MOE) as part of the requirement of the Polluted Sediments Committee under the Canada-Ontario Agreement (COA).

In the early 1970's, the Ontario Water Resources Commission (OWRC) developed guidelines for evaluating dredge spoils for open-water disposal (Persaud and Wilkins, 1976). The parameter levels selected by the OWRC were modified from U.S. criteria and reflected results of studies undertaken in Canadian harbours on the Great Lakes. The guidelines were based on data that indicated an association of certain elevated levels of contaminants with impaired water quality and/or the absence of certain benthic indicator species. In the case of mercury, the guideline was based on an apparent correlation with mercury levels in fish higher than the 0.5 ppm guideline for human consumption. Overall, however, the individual parameter levels were empirically derived and relate more to some incremental change above background levels for the nearshore zone of the Great Lakes than to a level related to known adverse effects on biota. These guidelines have also been used to evaluate sediment quality during routine surveillance and monitoring studies.

Open-water disposal guidelines were developed in 1976 for 11 heavy metals, nutrients, PCB's, cyanide and oil and grease (Table 1.1). The guidelines are based on bulk chemical analysis and, therefore, relate to the 'total' concentration of a respective chemical present in a given sediment sample. This approach provides basic guidance in environmental protection. However, it is not totally satisfactory for assessing the biological significance of contaminants in sediments, since the total concentrations of contaminants have generally little relationship to the amount released to the water column or their availability to biological organisms. Many studies have shown that a large fraction of heavy metals in sediments is not readily released to the water column or available for uptake by biota because it is associated with the mineral lattice of crystalline solids, strongly sorbed to particulate surfaces, or incorporated in organic materials (Gibbs, 1973; Walters and Wolery, 1974; Brannon et al., 1976a). Similarly, organic compounds, such as PCB's and organochlorine pesticides, generally have a low solubility and are tightly sorbed by clay particles and organic matter (Pionke and Chesters, 1973; Karickhoff et al., 1979).

More recently, the MOE (Draft, 1988) has extended the classification process to include options for land disposal of dredge spoils (Table 1.1). If the quality of the dredged material exceeds the open-water disposal guidelines, then the quality of the dredged material is compared to the unrestricted and restricted land use classifications. If the material fails to satisfy the restricted land use criteria, it is classified as a "waste", and must be evaluated by a leachate extraction procedure (MOE, 1985) to determine whether it is a hazardous waste. The unrestricted land use guideline is derived from the guidelines for sewage sludge utilization on agricultural lands (OMAF/MOE, 1981). The restricted land use guidelines are based on MOE "upper limits of normal" contaminant guidelines for urban soils (MOE, 1986).

In 1977, the United States Environmental Protection Agency (U.S. EPA)/United States Army Corps of Engineers (U.S. COE) Technical Committee on Criteria for Dredged and Fill Material developed a sediment bioassay implementation manual (U.S. EPA/U.S. COE, 1977). This manual provided the first formalized guidance for assessing the toxicological impact of dredged material disposal. It has become the standard reference for regulatory testing of dredged material prior to marine open water or confined disposal, and has been adopted by all U.S. Army COE Districts involved in ocean water disposal of dredged material. Basically, the procedures involve acute toxicity tests comparing the survival of sensitive aquatic organisms exposed to solid or liquid phases of candidate dredged material to the survival of those exposed to phases of uncontaminated reference sediments. Bioaccumulation potential is tested by analyzing tissues of surviving bioassay organisms after ten days exposure for elevated concentrations of contaminants. In the

Great Lakes Basin, the U.S. Army COE Districts rely primarily on bulk chemical characterization of sediments and comparison with U.S. EPA (1977) guidelines for the pollutional classification of Great Lakes harbour sediments (Table 1.2). Elutriate and acute toxicity testing have been used less frequently, although Buffalo District has unilaterally embarked on a comprehensive program of acute toxicity testing of harbour and navigational waterway sediments using the mayfly nymph Hexagenia limbata, the waterflea Daphnia magna and the fathead minnow Pimephales promelas (Revin, 1987).

As part of the U.S. EPA/U.S. COE regulatory initiative, comprehensive research programs have been or are being undertaken to address the development of impact prediction and assessment methods for dredged spoil disposal. These include the U.S. COE Dredged Material Research Program (Saucier et al., 1978), the ongoing Long-term Effects of Dredging Operations Program (e.g., Dillon, 1984), the ongoing Dredging Operations Technical Support Program (e.g., Salamon, 1984), and other work associated with the Waterways Experiment Station at Vicksburg, Mississippi (e.g., Peddicord et al., 1986). Research work resulting from these initiatives included evaluations of bioassay testing (e.g., Shuba et al., 1977; Rosenberger et al., 1978), chemical release potential (e.g., Jones and Lee, 1978), and bioaccumulation potential (e.g., Neff et al., 1978; Dillon, 1984). These evaluations extended to the implementation and assessment of specific protocols and methodologies during comprehensive field investigations in marine and Great Lakes locations (e.g., Sweeney, 1978; Salamon, 1984), as well as to the development of predictive models (e.g., McFarland, 1983).

The Wisconsin Department of Natural Resources has recently developed interim criteria for in-water disposal of dredged sediments (Sullivan et al., 1985). These were based on background concentration data for metals in recent and greater-than-200-year-old Lake Michigan sediments, metals in bluff material along the Lake Michigan shoreline, and average concentrations of selected metals and organic contaminants in surficial sediments from all the Great Lakes.

More recently, since 1985, the U.S. EPA Criteria and Standards Division has been pursuing development of sediment quality criteria for non-polar organic and metal contaminants. Interim criteria have been proposed for selected non-polar organics, in either freshwater or marine sediments, based on equilibrium partitioning principles (Battelle, 1988). In a parallel initiative, the U.S. EPA, Region 10, in conjunction with the

Washington State Department of Ecology, has been developing marine sediment quality criteria for Puget Sound based on apparent biological effects (PTI, 1988).

Under the Great Lakes Water Quality Agreement of 1978, the Dredging Subcommittee of the Great Lakes Water Quality Board (GLWQB) of the International Joint Commission (IJC) is responsible for the delineation of "specific criteria for the classification of polluted sediments of designated areas of intensive and continuing dredging activities within the Great Lakes system" (IJC, 1978). The development of compatible guidelines and criteria for dredging activities has been ongoing (Dredging Subcommittee, 1982), and includes a two-harbour evaluation to assess the practicality of the guidelines (Dredging Subcommittee, 1983, 1986).

Environment Canada and Fisheries and Oceans Canada have supported literature reviews and evaluations of available bioassessment methods for contaminated sediments (BEAK, 1980; Craig, 1984; Munawar et al., 1984). The resulting reports were used primarily as background documents in attempting to gain concensus among Federal, Provincial and State agencies in adopting a common bioassessment approach to testing dredged sediments in the Great Lakes. Bioassessment does not preclude the use of numeric chemical criteria. Both biological and chemical criteria may be used if the chemical criteria have a sound biological basis.

The MOE has supported a number of studies related to the assessment of dredging and dredged material disposal. For example, Krantzberg and Stokes (1983) developed a method for classifying the pollution status of sediments, involving physical (grain size) characterization, elutriate testing, fractionation and bioassay testing. BEAK/OCEANCHEM (1986) prepared a handbook of guidelines for dredging and dredged material disposal, which included recommended protocols for sediment bioassessment as well as tentative numerical sediment quality objectives for some persistent organic contaminants. Mudroch et al. (1986, 1988) have undertaken a review of the existing MOE guidelines for dredged material open water disposal based on a comprehensive review of the background and surficial concentrations of contaminants in sediments, including harbours, river mouths, bluffs and embayments of the Great Lakes. These initiatives have been jointly supported by the MOE and Environment Canada.

The historic deposition of persistent toxic substances into sediments has been singled out by the IJC as a major concern in many localized areas around the Great Lakes (IJC, 1985, 1987). Contaminated sediments from past discharges resulting in in-place pollutants are identified as a problem in 38 of the 42 areas of concern in the Great Lakes and connecting channels (IJC, 1983). These sediments can be a source of pollutants into and through the food chain. The GLWQB has recommended that methods be developed to determine the site-specific significance of in-place pollutants to permit evaluation of the effectiveness of alternative approaches to remediation.

Consequently, the MOE recently initiated the In-Place Pollutants Program to assess the impacts of in-place pollutants in sediments on the aquatic ecosystem and human health (e.g., Lomas and Persaud, 1987; Persaud and Lomas, 1987). The resulting database provides site-specific information on contaminant concentrations in sediments (including distribution of metal levels among sediment fractions), in benthic invertebrates and in bottom-feeding fish (sculpin), as well as the distribution and abundance of benthic invertebrates for various areas of the Great Lakes (e.g., Jaagumagi, 1987; Persaud et al., 1987).

As a result of these and other initiatives, a large database has been developed on:

- the release of contaminants in sediment to the overlying water;
- the lethal and sublethal effects of contaminated sediments on benthic biota; and
- bioaccumulation of contaminants from sediments by benthic biota and the potential for food chain biomagnification.

This large and expanding database appears now to provide sufficient information for the development of interim sediment quality guidelines for specific contaminants or contaminant classes.

The Polluted Sediments Committee under the Canada-Ontario Agreement (COA) has retained Beak Consultants Limited (BEAK) to prepare a review and assessment of this database as a basis for the identification of the strategies to be used in sediment quality guidelines development (Phase I, BEAK, 1987) and using this database to derive specific numeric guidelines (Phase II). The Phase II work, i.e., the actual development of the guidelines and supporting rationale, is summarized in this document.

TABLE 1.1: MOE DREDGED MATERIAL MODEL CLASSIFICATION CRITERIA[1]

Parameter	Concentration (ppm) Open Water Disposal	Concentration (ppm) Unrestricted Land Use	Concentration (ppm) Restricted Land Use
Group 1			
Cadmium	1.0	1.6	4.0
Lead	50.0	60.0	500.0
Mercury	0.3	0.5	0.5
PCBs	0.05	2.0	2.0
Group 2			
Arsenic	8.0	14.0	20.0
Copper	25.0	100.0	100.0
Zinc	100.0	220.0	500.0
Chromium	25.0	120.0	120.0
Iron	10,000.0	35,000.0	35,000.0
Nickel	25.0	32.0	60.0
Cobalt	50.0	20.0	25.0
Silver	0.5	-	-
Cyanide	0.1	-	-
Molybdenum	-	4.0	4.0
Selenium	-	1.6	2.0
Group 3*			
Loss on Ignition	6.0%	-	-
Oil and Grease	1,500	-	-
Total Phosphorus	1,000	-	-
Total Kjeldahl Nitrogen	2,000	-	-
Ammonia	100.0	-	-

[1] After MOE (Draft, 1988).

* Group 3 parameters are subject only to open-water disposal criteria.

TABLE 1.2: U.S. EPA, REGION V, GUIDELINES FOR THE POLLUTIONAL CLASSIFICATION OF GREAT LAKES HARBOUR SEDIMENTS[1]

Contaminant	Concentration (mg/kg dry weight) Non-polluted (less than)	Moderately Polluted	Heavily Polluted (greater than)
Volatile Solids	5%	5%-8%	8%
COD	40,000	40,000-80,000	80,000
TKN	1,000	1,000-2,000	2,000
Oil and Grease	1,000	1,000-2,000	2,000
Lead	40	40-60	60
Zinc	90	90-200	200
Ammonia	75	75-200	200
Cyanide	0.10	0.10-0.25	0.25
Phosphorus	420	420-650	650
Iron	17,000	17,000-25,000	25,000
Nickel	20	20-50	50
Manganese	300	300-500	500
Arsenic	3	3-8	8
Cadmium	*[2]	*	6
Chromium	25	25-75	75
Barium	20	20-60	60
Copper	25	25-50	50
PCB[3]	10	n.a.[4]	10
Mercury[3]	1	n.a.	1

[1] Adapted from EPA (1977).

[2] Lower limits not established.

[3] Pollutional classification of PCB and mercury based on two categories: non-polluted and polluted.

[4] n.a. = not applicable.

2.0 METHODS

2.1 Sediment Quality Guideline Development

Methods which have been used to derive sediment quality guidelines were reviewed in Phase I of this study (BEAK, 1987) and are briefly described again in this section. Nine methods were recognized in Phase I, although they can be grouped in different ways to form either more or fewer categories. The nine methods were as follows:

1. Sediment Background Approach
2. Sediment-Water Equilibrium Partitioning
3. Sediment-Water-Biota Equilibrium Partitioning
4. Sediment-Biota Equilibrium Partitioning
5. Empirical Partitioning
6. Apparent Effects Threshold
7. Screening Level Concentration
8. Field Bioassay
9. Spiked Bioassay

We do not consider sediment-biota partitioning since direct sediment-biota partition coefficients, when they have been defined, tend to be extremely variable, and site-specific (perhaps according to local feeding habits) rather than generic. Moreover, there are little data available on which to base a generic coefficient.

Nor do we consider the empirical partitioning approach, since this is essentially a site-specific version of sediment-water partitioning, and produces site-specific rather than generic guidelines. Site-specific guidelines may be more realistic than generic guidelines, particularly for contaminants which are highly variable in their partitioning behaviour under different conditions and from site to site (for example, metal partitioning is variable and poorly understood). However, site-specific guidelines may be more difficult and costly to enforce.

Finally, we do not consider the field bioassay approach in this report, since we were only able to find one field bioassay study in which a single contaminant was identified as responsible for the observed effects (this study was included in the spiked bioassay analysis). Thus, six methods are described below.

2.1.1 Sediment Background Approach

In the background approach, sediment contaminant concentrations at a particular location are compared to concentrations from reference (background) sites, where contaminant levels are deemed to be acceptable. Mudroch et al. (1986, 1988) provide an example of this approach. They have undertaken an evaluation of the existing MOE guidelines for dredged material open water disposal based on a comprehensive review of the background and surficial concentrations of contaminants in sediments, including harbours, river mouths, bluffs and embayments of the Great Lakes.

The primary advantage of the background approach is that it has minimal data requirements. The establishment of background contaminant concentrations does not require the collection of extensive field data, particularly in areas, such as the Great Lakes, where historical data are available. This approach is the only method for establishing sediment quality guideline values that does not require quantitative toxicological data for the specific contaminants in sediment.

The limitations of this approach are the difficulties inherent in developing a technically and legally defensible method of selecting a "suitable" reference area, or determining what is an "acceptable" level of contamination. We have adopted a 'pre-industrial' standard for metal concentrations (based on core data) and, for strictly anthropogenic organic contaminants, a contemporary upper Great Lakes surficial sediment standard.

2.1.2 Sediment-Water Equilibrium Partitioning

The sediment-water equilibrium partitioning approach has been undertaken by Pavlou and Weston (1983, 1984), Bolton et al. (1985) and Kadeg et al. (1986), primarily for nonpolar organic chemicals. This approach is based on the assumption that the distribution of contaminants among different compartments in the sediment is controlled in a predictable manner by a continuous equilibrium exchange among sediment solids and interstitial water. It is also assumed that interstitial water is the primary route of organism exposure. Using this approach contaminant-specific partition coefficients are determined (generally expressed in terms of organic carbon content in the sediment) and used to predict the distribution of the contaminant between sediment and interstitial water. The coefficient is considered to be generic (equally applicable at all sites). The coefficient, K_{oc}, is multiplied by an existing water quality criterion to derive a sediment quality guideline in ug/g organic carbon. This guideline is also generic, and is multiplied by the sediment organic carbon fraction (TOC) to derive a bulk guideline for each site.

Partitioning of nonpolar organic compounds is reliably represented by K_{oc}, which in turn can be predicted from K_{ow} (the octanol/water partition coefficient). We have collected K_{oc} values from the literature, relying where possible on an EPA pre-screening (Battelle, 1988), and have determined geometric means and confidence limits of partitioning coefficients for each chemical. Sediment guidelines were derived using both mean and lower confidence limit values.

An advantage which this approach shares with other partitioning approaches is that it relies on an existing toxicological rationale which was established during water quality criteria development. Thus, a new toxicological evaluation is not required if the water quality criteria were derived to protect the benthic organisms which are exposed to the interstitial water. However, a corresponding limitation of the approach is its applicability only to chemicals which have water quality criteria. Moreover, if water and sediment criteria are meant to protect different organisms, then an assumption is made that the two sets of organisms are equally sensitive to pollution.

2.1.3 Sediment-Water-Biota Equilibrium Partitioning

The sediment-water-biota equilibrium partitioning approach is a generic partitioning method which derives a sediment quality guideline from an existing tissue quality criterion. It is a two-step approach utilizing a generic water-biota bioconcentration factor (BCF) to translate the tissue criterion into a corresponding water concentration (Final Residue Value, FRV). After this first step, the approach is identical to that described in Section 2.1.2, using the FRV as a water quality criterion.

The tissue criterion is generally based on human health considerations and human food consumption patterns. Therefore, the tissue criterion applies to a human food organism, such as fish, rather than to benthos. Similarly, the BCF applies to fish and the derived water concentration applies to the water column in which the fish lives. There is a substantial gap between this water column compartment and the interstitial water compartment presumed to be in equilibrium with the sediments. The reduction in contaminant concentration from the interstitial to the water column compartment is likely to be highly site-specific, depending on local circulation. However, as there is certain to be some reduction, it is conservative to assume none (i.e., multiply the FRV directly by K_{oc} to derive a sediment quality guideline).

We derived FRV water concentrations using MOE/MNR (1988) or Health and Welfare (1987) guidelines for consumption of toxic organic residues in fish tissue, divided by bioconcentration factors from the literature. This was done for organic contaminants only, since metal partitioning in sediments was not considered to be sufficiently predictable to justify selection of generic partitioning coefficients.

This sediment-water-biota partitioning approach assumes that the primary route of fish exposure is through the water rather than the food chain. The assumption has not received adequate testing for most persistent toxic substances. As chemical hydrophobicity (K_{ow}) increases, the food chain is likely to become more significant and, by ignoring it, we may be overestimating acceptable chemical concentrations in sediments. However, Mackay (pers. comm.) suggests that bioaccumulation factors (which encompass both food chain and water exposure routes) seldom exceed the corresponding BCF (water only) by more than one order of magnitude (approximately three times for each food chain step; Mackay et al., 1987).

2.1.4 Apparent Effects Threshold

The Apparent Effects Threshold (AET) approach was developed by Tetra-Tech (1986) and has been used extensively by PTI, Inc. (1988) in Puget Sound and Commencement Bay to establish sediment quality guidelines for the State of Washington (Department of Ecology). The basis of the technique is simple: to find the sediment concentration of a contaminant above which significant biological effects are always observed. It is assumed that effects above this contamination level are specifically related to the contaminant of interest, while below this level any effects observed could be due to other contaminants.

In practical application of the method, species and biological endpoints must be carefully selected to ensure the desired level of protection for the benthic community. If species and endpoints are mixed, the least sensitive of these will always dominate. For example, if the database for a particular contaminant contains data on acute toxicity to tubificid oligochaetes, then the AET will be designed to protect against acute toxicity to tubificids. It will not protect other more sensitive species, nor will it provide chronic protection.

A consistent definition of significance should also be used. If statistically defined, different alpha levels (probability of Type I error) may be utilized by different authors. This represents an inconsistent definition of significance. Moreover, the reference point for comparison may differ between studies. While most authors use some sort of control as a reference point, it is unlikely that the control site or treatment represents the same level of benthic community health in all studies.

Ideally, data from a single investigator would be utilized to ensure consistency; however, it is seldom possible to obtain data over a sufficient concentration range for all contaminants of interest from a single study. We relied heavily on acute toxicity data from the U.S. Corps of Engineers (Aqua-Tech, 1983-1986) in compiling an AET database for freshwater sediments, although data from 59 sources were utilized. For acute toxicity endpoints, we used only data in which control survival was 90% or better.

We computed AETs for various data subsets, restricted by test species and endpoint, in order to compare the guideline values obtained. Calculations were performed without TOC-normalization, following the Tetra-Tech (1986) approach, since much of the available data did not include TOC measurements.

2.1.5 Screening Level Concentration

The Screening Level Concentration (SLC) approach was developed and tested by Battelle (Neff et al., 1986) primarily for use with nonpolar organic compounds. The approach uses field data on the co-occurrence in sediments of benthic infaunal species and different concentrations of contaminants. The SLC is an estimate of the highest concentration of a contaminant that can be tolerated by approximately 95% of benthic infaunal species.

Calculation of the SLC is a two-stage process. First, for a large number of species (at least ten for each chemical), the species SLC (or SSLC) is calculated as the 90th percentile of the concentration distribution over all sites (at least ten) where the species is present. Second, the 5th percentile of the SSLC distribution is determined. This is the concentration which 95% of species tolerate.

An implicit assumption is that the database includes concentrations over the full range of tolerance for each species. This is important, though sometimes difficult to verify. An SLC will be generated whether or not the assumption is satisfied.

Since the method was developed for nonpolar organic contaminants, sediment concentrations are TOC-normalized in an effort to represent contaminant availability to the organism (i.e., concentration expressed in ug/gC). However, the method can be applied without TOC-normalization for contaminants whose availability is better represented by bulk sediment concentration. We applied the method both ways, and also converted TOC-normalized SLC criteria to a bulk sediment basis using an assumption of 4% TOC in sediments. This value closely approximates the average TOC concentration in sediment samples represented in the SLC database.

2.1.6 Spiked Bioassay Approach

In this approach, dose-response relationships are determined by exposing test organisms to sediments that have been spiked with known amounts of contaminants. Sediment quality guideline values can then be determined using the sediment bioassay data in the manner that aqueous bioassays were used to establish water quality criteria.

In contrast to the field-based approaches described previously, the spiked bioassay approach can establish cause-and-effect relationships between contaminants and toxic biological responses. Contaminants can be tested individually or in combination. Furthermore, interactive effects of contaminant mixtures can be identified and quantified.

The major limitation of this approach is the amount of research effort required to test potentially toxic contaminants. The spiked bioassay approach has been used primarily for metals (e.g., Birge et al., 1977; Cairns et al., 1984; Francis et al., 1984; Nebeker et al., 1986a), although some preliminary bioassay work has been undertaken with sediments enriched with nonpolar organic contaminants (e.g., White, 1984). This research has generally involved short-term acute exposures with a small number of benthic species.

Both acute and chronic endpoints were included in the analysis, with a downward adjustment of acute values by 1/10 to represent a chronic protection level. Then the lowest LC50 or EC50 was selected as a sediment quality guideline.

2.2 Data Sources and Compilation

A complete list of references which contributed data for each approach to sediment quality guideline development is provided in Section 7.0. This section briefly describes the type of data utilized, criteria for data acceptability, and some of the major data sources.

Background data were collected from 27 references listing 'background' metal concentrations in Great Lakes sediments, based on analysis of core samples. Background horizons were variously defined, but always represented pre-industrial conditions for metals. A key source of data was Mudroch et al. (1986, 1988). Data from different lakes and areas within lakes (e.g., embayments, non-depositional, depositional) were pooled following initial inspection of the data which revealed no obvious differences in background between lakes or areas. For strictly anthropogenic organic contaminants, a contemporary upper Great Lakes surficial sediment background was derived, primarily from reports by Glooschenko et al. (1976) and Frank et al. (1979).

Generic sediment-water partitioning coefficients for organic pesticides and PCB's were selected primarily from reports to the U.S. EPA (Battelle, 1988; Pavlou and Weston, 1983, 1984) in support of its sediment quality criteria development program. Some additional coefficient values for p,p-DDT and four specific PCB Aroclors were added to this compilation, from other sources, and coefficients were computed following Battelle (1988) methods (geometric mean and 95% confidence limits on K_{ow} and hence K_{oc}). Values measured experimentally or calculated by fragment analysis or aqueous solubility methods were considered acceptable.

A toxicity database was constructed for AET calculations, containing data from 59 different sources. The U.S. Corps of Engineers data (Aqua-Tech, 1983-1986) comprised a large portion of this database. The samples tested were primarily natural Great Lakes sediment samples (unspiked) with multiple contaminants present. Bulk concentrations of each contaminant were recorded. The test organisms included benthic invertebrates (e.g., Hexagenia, Hyallela, Chironomus) and fish (e.g., Ictalurus, Pimephales, Salmo gairdneri). Hexagenia was the single most common organism represented. Test durations varied from 1 to 21 days with four-day tests most common. Response measures included survival, growth, biomass production and larval emergence, with survival the most common response measure. A code entered with each response indicated its significance relative to the control (or lowest concentration). In ASCII format, the database was approximately four megabytes in size.

A benthic species database was constructed for SLC calculations containing data from 19 Great Lakes benthic survey reports. Bulk concentrations of contaminants in sediments, along with TOC and percent fine material (< 63 um diameter), were entered with a presence-absence (0, 1) code for each of 100 benthic species. The species selected were common throughout the Great Lakes, and included both pollution sensitive and tolerant taxa. In general, only taxa identified to species level were utilized. However, in some cases (e.g., Tubifex sp.) where all species in a particular genus have essentially the same pollution status (i.e., sensitive or tolerant), genus level taxonomy was used. In ASCII format, this database was approximately four megabytes in size.

A second benthic species database was constructed from two MOE In-Place Pollutants program survey reports. This database was approximately 0.5 megabytes in size. Separate SLC calculations were performed on this database for selected metals with sufficient data present. This strategy was adopted to gain some insight into the robustness of the method as applied to different data sets of different sizes.

Spiked bioassay data were collected from nine sources, and represented a variety of test organisms (fish and amphibian embryos, amphipods, midges, Hexagenia, oligochaetes), test durations (3 to 14 days) and response measures (survival, larval deformity, avoidance). Studies involving chromium, cadmium, copper, mercury, zinc and endrin were included. Only one to a few LC50, EC50 or no-effect threshold values were available for each contaminant.

3.0 RESULTS AND DISCUSSION

3.1 Background Approach

In the background approach, sediment contaminant concentrations at a particular location are compared to concentrations from reference (background) sites, where contaminant levels are deemed to be acceptable.

The primary advantage of the background approach is that it has minimal data requirements. The establishment of background contaminant concentrations does not require the collection of extensive field data, particularly in areas such as the Great Lakes, where historical data are available. This approach is the only method for establishing sediment quality guideline values that does not require quantitative toxicological data for the specific contaminants in sediment.

The limitations of this approach are the difficulties inherent in developing a technically and legally defensible method of selecting a "suitable" reference area, or determining what is an "acceptable" level of contamination.

3.1.1 Heavy Metals

As a start for undertaking the background approach to the development of sediment quality guidelines for metals, BEAK made use of a comprehensive review of the surficial and background concentrations of contaminants in Great Lakes sediments (Mudroch et al., 1986, 1988). This review compiled the concentrations of arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel and zinc for depositional basins, areas with no deposition of fine-grained sediments (e.g., nearshore zones), embayments, harbours, tributary mouths and, where available, for shoreline bluffs. The background concentrations represented usually those in the pre-colonial sediments as determined by the Ambrosia pollen horizon or radionuclide dating of the sediments. In some cases, the background was the concentration that an element reached at certain sediment depth without further concentration changes below this depth.

BEAK reviewed readily available literature on background metal concentrations in Great Lakes sediments to verify the data presented by Mudroch et al. (1985, 1988), as well as to provide additional data from other sources. Sediment background concentrations for manganese were delineated during this review.

Many surveyed reports contained only a summary of results, or mean concentrations with standard deviation, or a range of concentrations. To facilitate a statistical evaluation of reported concentrations, summarized results (mean concentrations or range midpoints) were tabulated and treated as single background values. Since no obvious differences in the values from different areas (i.e., depositional, non-depositional, river mouth, etc.) could be discerned, all such background values were used to calculate the overall mean concentration and the 95% confidence interval on the background value distribution. The confidence interval was arithmetic for most metals, but geometric for mercury, as appropriate to the background data distributions. Table 3.1 presents the overall mean and maximum background metal concentrations and the 95% upper confidence intervals. Detailed tabulation of the data is provided in Appendix A.

In order to define a sediment quality guideline based on background, that most background samples could meet, without allowing undue influence of extreme data points, BEAK suggests the use of the upper 95% confidence limits (after rounding) as background limits for metals in Great Lakes sediments, rather than maximum concentrations. The proposed sediment quality guidelines for metals based on this background approach are presented and compared to other sediment quality regulatory guidelines in Table 3.2. The proposed sediment quality guideline value for arsenic is tentative, as it is based on only a few background concentration values. For arsenic, a 90% upper confidence limit was used to provide a slightly more conservative interim sediment quality guideline.

The proposed guideline values were consistently higher than the MOE and U.S. EPA dredge spoil guidelines, ranging from only slightly higher for lead to 3-6 times higher for iron and four times higher for manganese. The exception was the U.S. EPA guideline value (1 ug/g) for mercury, which was slightly higher than the proposed guideline value (0.6 ug/g). Compared to the sediment quality guidelines based on the background approach used in this study, the Wisconsin Department of Natural Resources guideline values were higher for chromium, copper and nickel, and lower for cadmium, lead, mercury, zinc and arsenic.

A number of other approaches have been taken in the past to define background concentrations of metals in Great Lakes sediments. These include:

- mean concentrations in erodable bluff materials (e.g., Kemp and Dell, 1976; MOE, 1988);
- mean plus two standard deviations of concentrations found in surficial sediments at 25 'undeveloped' tributary mouths around the Great Lakes (Fitchko and Hutchinson, 1975);
- concentrations found in Pleistocene lake sediments (Frye and Shimp, 1973); and
- mean values found in surficial sediments collected at 28 locations selected as representative of 'non-contaminated' areas in Michigan.

Table 3.3 presents the mean background metal concentrations based on these other approaches, for comparative purposes only.

The sediment quality guideline values for arsenic, cadmium, chromium, iron and lead, based on the background approach used in this study, were generally in the upper range of background values obtained by these other approaches. For copper, manganese, mercury, nickel, zinc and arsenic, the proposed sediment quality guideline value was higher than the background values obtained by the other approaches. The lower values obtained by the other approaches likely reflect lower substrate capacity for metal sorption in the samples selected to represent background, due to low organic matter and/or larger particle size (e.g., sand).

3.1.2 Organochlorine Pesticides and PCBs

For the organochlorine pesticides and PCBs, background concentrations are zero, because these contaminants did not exist prior to the industrialization of the Great Lakes Basin. This is supported by sediment core data as the organics concentrations in deeper sections of the core are always below the detection limit (Appendix Table A-12). Similarly, the concentrations of organics in erodable bluff materials are consistently below the detection limit (Appendix Table A-13). However, a background concentration of zero cannot realistically be utilized as a sediment quality guideline for these organic contaminants, since analytical systems have greater than zero detection limits. Nor is a background concentration equal to some specified BAT detection limit realistic, since these organic contaminants are now widely distributed throughout the Great Lakes at low but detectable levels.

To overcome this difficulty, it is proposed that an overall mean concentration of organic contaminants in surficial sediments in the Upper Great Lakes proper could be used as a contemporary benchmark reflecting the current level of contamination. The rationale for this approach is that production and loadings of these organics have generally been substantially curtailed and the concentrations in Great Lakes proper surficial sediments will continue to decline due to natural physical-chemical and biological processes, e.g., volatilization, dilution, photo-oxidation, biodegradation. Furthermore, organic concentrations in the Great Lakes proper surficial sediments are generally lower relative to concentrations in Great Lakes tributaries, harbours and embayments (Appendix Table A-14). Finally, organic contaminant concentrations in surficial sediments of the Upper Great Lakes are consistently lower than in the Lower Great Lakes (Appendix Table A-15). Therefore, the use of the maximum lake mean of organic contaminant concentration values in surficial sediments of Lakes Superior and Huron provides a conservative benchmark for organics in the Great Lakes as a whole.

The proposed sediment quality guidelines for the organochlorine pesticides and PCBs based on contemporary benchmark concentrations in surficial sediments of the Upper Great Lakes proper are presented and compared to other sediment quality regulatory guidelines in Table 3.4. The proposed guideline values were consistently lower than any available regulatory guidelines, with the exception of that for total DDT which was the same as the WDNR guideline value.

3.2 Equilibrium Partitioning

The U.S. EPA has been pursuing the Equilibrium Partitioning (EP) approach for estimating sediment quality guidelines for nonpolar and metal contaminants since 1985. At present, interim guidelines have been developed for selected organic compounds, including several PAHs and pesticides, as documented in a report recently prepared by Battelle (1988).

The EP approach is based on two initial assumptions. First, it is assumed that contaminant concentrations in interstitial waters are controlled by equilibrium partitioning between the solid and liquid phases at contaminant levels well below saturation in either phase. On this basis, partitioning can be calculated from the quantity of sorbent in the sediment and from the appropriate coefficient. For nonpolar organic substances, organic carbon in the sediment is the primary sorbent, and the partition coefficient, K_{oc}, is normalized for sediment organic content. The second assumption is that the toxicity or bioaccumulation potential of contaminants in sediments is correlated with the aqueous interstitial phase rather than with total (bulk) sediment concentrations.

The EP approach goes on to use existing water quality criteria and K_{oc} values to derive sediment quality guidelines. Battelle (1988) used chronic water quality criteria (the lowest concentration in water known to cause chronic effects on aquatic biota) and final residue values (concentrations in water that result in maximum permissible concentrations in humans or wildlife, based on food chain modelling) to derive sediment quality guidelines. Final residue values (FRVs) are generally based on U.S. Food and Drug Administration (FDA) concentration limits for contaminants in human food. K_{oc} values are generally estimated from octanol/water partition coefficients, which are widely available in the literature. Thus, sediment quality guidelines (SQG) may be calculated from water quality criteria (WQC) as follows:

$$SQG = K_{oc} \times WQC$$

where: WQC is either a chronic effects limit or an FRV.

The Battelle (1988) report compiles K_{ow} and K_{oc} values for several organic contaminants, and calculates statistical distributions for the data. This approach permits the derivation of statistical uncertainties for sediment quality guidelines. Thus, the lower value of a 95% confidence limit represents the concentration which with 97.5% certainty will result in protection against either chronic toxicity or unacceptable bioaccumulation.

In utilizing existing water quality criteria as a basis for sediment quality guidelines, a third assumption is made that the organisms meant to be protected by the SQG are comparable in sensitivity to the organisms protected by the WQC, and that there is intent to afford an equivalent degree of protection to these two groups of organisms. This assumption requires careful scrutiny, particularly when FRVs based on human health considerations are used as water quality criteria.

For this evaluation, sediment quality guidelines as developed by Battelle are summarized for contaminants of concern. In addition, existing provincial (MOE, 1984) water quality objectives (PWQOs) and available K_{oc} values are used to derive sediment quality guidelines for Ontario. Finally, existing provincial guidelines for fish residues (Health and Welfare, 1987; MOE/MNR, 1988) and federal guidelines for meat residues (Health and Welfare, 1987) were used to derive sediment quality guidelines for Ontario.

Table 3.5 summarizes $\log_{10} K_{ow}$ values for contaminants of concern. Emphasis is given to values evaluated by Battelle (1988) in the derivation of sediment quality guidelines, or those calculated in the Montana State University (MS) QSAR database by the fragment analysis method. Where no values were found in these databases, the recent U.S. EPA review (Kadeg et al., 1986) or an earlier U.S. EPA (1979) review were used to compile K_{ow} values. No K_{ow} values were found for mirex, heptachlor epoxide and some of the chlordane isomers.

Table 3.6 presents K_{oc} values derived from the following equation (DiToro, 1985):

$$\text{Log}_{10}(K_{oc}) = 0.00028 + 0.983\ \text{Log}_{10}(K_{ow})$$

The 95% confidence limits presented in Table 3.6 for K_{oc} values are derived from the corresponding confidence limits for the geometric mean Log K_{ow} values, as calculated by Battelle (1988).

Sediment quality guidelines based on PWQOs, are derived in Table 3.7 using the K_{oc} values given in Table 3.6. The criteria are expressed on an organic carbon basis, so that the bulk criterion for a particular sediment is equal to the tabulated value times the fractional carbon content (TOC). It should be noted that, for compounds having only one Log K_{oc} value with no confidence limits, sediment quality guidelines should be interpreted with caution. Aldrin, and hexachlorobenzene in particular, are shown to have very high K_{oc} values leading to high guideline values that may seriously underestimate hazard.

Sediment quality guidelines derived by Battelle (1988) (Table 3.8) are more restrictive when based on final residue values than when based on chronic toxicity, due to the considerable potential for food chain biomagnification of these compounds, and/or the greater degree of protection desired for humans vs. aquatic biota. Sediment quality guidelines derived in this study from MOE/MNR (1988) and Health and Welfare (1987) residue limits (Table 3.9) were sometimes higher (PCB, DDT, dieldrin) and sometimes lower than corresponding guidelines based on PWQO's.

Where comparisons are possible between sediment quality guidelines derived by Battelle (1988), and those derived in this study from PWQOs, the guidelines based on PWQOs are consistently lower than Battelle's FCV-based criteria. Guidelines based on PWQOs are also generally lower than Battelle's FRV-based criteria, with two exceptions (chlordane and total DDT). These differences are entirely due to differences in the water quality criteria, since the same K_{oc} values were used. Guidelines based on Canadian residue limits are also generally lower than Battelle's FRV-based criteria, with one exception (total DDT), primarily due to international differences in existing residue limits.

3.3 Apparent Effects Threshold

The Apparent Effects Threshold (AET) approach was developed by Tetra-Tech (1986) and has been used extensively by PTI, Inc. (1988) in Puget Sound and Commencement Bay to establish sediment quality criteria for the State of Washington (Department of Ecology). The basis of the technique is simple: to find the sediment concentration of a contaminant above which significant biological effects are always observed. It is assumed that effects above this contamination level are specifically related to the contaminant of interest, while below this level any effects observed could be due to other contaminants.

In practical application of the method, species and biological endpoints must be carefully selected to ensure the desired level of protection for the benthic community. If species and endpoints are mixed, the least sensitive of these will always dominate. For example, if the database for a particular contaminant contains data on acute toxicity to tubificid oligochaetes, then the AET will be designed to protect against acute toxicity to tubificids. It will not protect other more sensitive species, nor will it provide chronic protection.

A consistent definition of significance should also be used. If statistically defined, different alpha levels (probability of Type I error) may be utilized by different authors. This represents an inconsistent definition of significance. Moreover, the reference point for comparison may differ between studies. While most authors use some sort of control as a reference point, it is unlikely that the control site or treatment represents the same level of benthic community health in all studies.

Ideally, data from a single investigator would be utilized to ensure consistency; however, it is seldom possible to obtain data over a sufficient concentration range for all contaminants of interest from a single study. We relied heavily on acute toxicity data from the U.S. Corps of Engineers (Aqua-Tech, 1983-1986) in compiling an AET database for freshwater sediments, although data from 59 sources were utilized. For acute toxicity endpoints, we used only data in which control survival was 90% or better.

Where authors reported statistical significance based on replicate data, or we were able to perform the test ($p < 0.05$), this was used as the criterion of significance, and an effect significance code of 0 or 1 was assigned. In other studies, where a statistical comparison to control was lacking, but a dose-response was evident, a code reflecting loss of normal function relative to control was assigned to each response:

Code	% of Control
0	≥80
2	<80
3	70
4	60
5	50
6	40
7	30
8	20
9	10

Any code of one or greater was considered significant for purposes of AET estimation.

The response code was plotted against concentration for each contaminant in order to:

- determine the AET concentration above which all responses were significant; and
- determine whether the response level tended to increase with concentration.

If the highest concentration did not ellicit a significant response, then an AET could not be calculated.

These AET plots were produced using three different data subsets for each chemical parameter:

- all data (multiple species and endpoints),
- survival data only (multiple species), and
- *Hexagenia* survival only.

Survival was the most common endpoint in the database, and *Hexagenia* was the most common single species. *Hexagenia* is well known as a sensitive species present in most pristine freshwater environments. However, the acute toxicity tests which dominate the database do not generally use the most sensitive life stages. This is a limitation of the available AET database.

The AET plot for copper, based on *Hexagenia* survival, is shown in Figure 3.1. More data were available for copper than for any other compound. Similar plots for lead and zinc are shown in Figures 3.2 and 3.3, respectively. No other AET values could be calculated based on *Hexagenia* survival (i.e., highest concentrations were ineffective). The survival measure was typically an acute test endpoint.

Table 3.10 lists the AET values derived from all three data subsets, compared to regulatory criteria. The toxicity data supporting each AET, from the highest ineffective concentration to the highest concentration studied, are listed in Appendix Tables B-1 to B-3 for copper, lead and zinc. The AET based on *Hexagenia* is consistently lower than that based on a multiple species data set, as is expected from the known sensitivity of this species. *Hexagenia* AETs could not be calculated for organic contaminants.

Multiple species AETs for organic contaminants were often 'less than' concentration values. In some cases (endrin, chlordane), it was possible to compute an AET using quantitative concentrations only. In these cases, both AET values are shown in the table.

For metals, the AET guidelines tend to be higher than either the background or partitioning guidelines. They also tend to be higher than the SLC guidelines (Section 3.4). An order of magnitude correction has been suggested to adjust from acute to chronic protection (Mackay et al., 1987). Such an adjustment to Hexagenia AETs would yield guidelines in the same range as other methods.

For organic contaminants, AET guidelines are less supportable, since they cannot be computed from Hexagenia data (or for any other single, sensitive species). In some cases (e.g., heptachlor), multiple species AETs exceed partitioning guidelines by approximately an order of magnitude, while in other cases (e.g., total DDT) they are close to partitioning values.

3.4 Screening Level Concentration

The Screening Level Concentration (SLC) approach was developed and tested by Battelle (Neff et al., 1986) primarily for use with nonpolar organic compounds. The approach uses field data on the co-occurrence in sediments of benthic infaunal species and different concentrations of contaminants. The SLC is an estimate of the highest concentration of a contaminant that can be tolerated by approximately 95% of benthic infaunal species.

Calculation of the SLC is a two-stage process. First, for a large number of species (at least ten for each chemical), the species SLC (or SSLC) is calculated as the 90th percentile of the concentration distribution over all sites (at least ten) where the species is present. Second, the 5th percentile of the SSLC distribution is determined. This is the concentration which 95% of species tolerate.

An implicit assumption is that the database includes concentrations over the full range of tolerance for each species. This is important, though sometimes difficult to verify. An SLC will be generated whether or not the assumption is satisfied.

Since the method was developed for nonpolar organic contaminants, sediment concentrations are TOC-normalized in an effort to represent contaminant availability to the organism (i.e., concentration expressed in ug/gC). However, the method can be applied without TOC-normalization for contaminants whose availbility is better represented by bulk sediment concentration. We applied the method both ways, and also converted TOC-normalized SLC criteria to a bulk sediment basis using an assumption of 4% TOC in sediments.

Table 3.11 summarizes the results of these calculations for the main database. Bulk sediment SLCs for metals are invariably lower than background and, therefore, of limited use. However, TOC-normalized SLCs, when adjusted back to a bulk sediment basis for purposes of comparison, tend to be slightly above background for most metals (mercury and manganese values are slightly below). For the nonpolar organics, these SLC guidelines tend to exceed equilibrium partitioning guidelines by one to two orders of magnitude.

The implication of bulk SLCs below the upper limit of background, if bulk concentrations are assumed to represent toxic potential, is that some of the higher background concentrations would have adverse impacts on some sensitive species. This is quite possible, although it does not provide a practical SLC guideline. Alternatively, this situation could arise from not covering the full metal tolerance range of all species in the SLC database, hence underestimating some of the SSLCs. For most species, there is insufficient toxicity test data to resolve this issue.

The fact that TOC-normalized SLCs for metals, when adjusted back to a bulk sediment basis, tend to be higher than bulk SLCs, indicates that the lowest SSLCs tend to be from lower-than-average TOC samples. It is reasonable that such samples would be particularly toxic if TOC controls metal availability. However, the backward adjustment based on average TOC for the database, is for purposes of comparison only. The guidelines would be expressed in ug/g C. The best normalization procedures for representation of metal availability are as yet unresolved. DiToro et al. (1987) have recently proposed a more complex procedure, based on TOC, Fe and Mn oxide concentrations, and sediment porosity.

Appendix Figures C-1 to C-31 show SLC plots for metals and nonpolar organic contaminants, using the main database. The species represented on each plot can be determined from Appendix Tables C-1 to C-31 listing the SSLCs for each species. In total, 100 benthic species (Appendix Table C-32) were included in the analysis, although the species used for any particular contaminant were only those present with the contaminant at ten or more sites. The SLC method is highly dependent on the number of tolerant vs. sensitive species included in the database.

Appendix Figures D-1 to D-7, and Tables D-1 to D-7 show SLC plots and SSLC listings for arsenic, chromium, copper, iron, mercury, zinc and PCBs, based on the MOE In-Place Pollutants database. Table D-8 shows that the SLC values derived from this database are generally comparable to those listed in Table 3.11. The greatest differences are for PCBs and arsenic, where the SLCs based on MOE data, if bulk concentrations are assumed to represent toxic potential, are respectively 0.25 and 0.45 times those listed in Table 3.11.

3.5 Bioassay Approach

In this approach, dose-response relationships are determined by exposing test organisms to sediments with a known single toxicant concentration or that have been spiked with known amounts of the contaminant. Sediment quality criteria values can then be determined using the sediment bioassay data in the manner that aqueous bioassays are used to establish water quality criteria.

In the field-based approach using sediments with known single toxicant concentrations, the presence of other contaminants may influence the sublethal or lethal response due to synergistic or antagonistic effects. In contrast, the spiked bioassay approach can establish more definitively cause-and-effect relationships between contaminants and toxic biological responses. Contaminants can be tested individually or in combination. Furthermore, interactive effects of contaminant mixtures can be identified and quantified.

Spiking techniques for spiked bioassays have not been standardized (e.g., metal salts or solvent carriers, mixing procedures, equilibration periods, type of substrate). These methodological variations can strongly influence the bioassay result and will contribute to the variability of a database incorporating results from different laboratories. Standardization of technique would increase the usefulness of new spiked bioassay data.

The major limitation of this approach is the amount of research effort required to test potentially toxic contaminants. The field-based approach has been undertaken by Malueg et al. (1984a, b), where copper was identified as the toxic contaminant. The spiked bioassay approach has been used primarily for metals (e.g., Birge et al., 1977; Cairns et al., 1984; Francis et al., 1984; Nebeker et al., 1986a; Kosalwat and Knight, 1987a, b), although some preliminary bioassay work has been undertaken with sediments enriched with nonpolar organic contaminants (e.g., White, 1984; Keilty, 1987; Keilty et al., 1988). However, this research has generally involved short-term acute exposures with only a small number of benthic macroinvertebrate and fish species.

Table 3.12 presents available dose-response data based on the bioassay approach.

A number of other studies involving the bioassay approach were reviewed. However, the experimental results did not suit the required format for inclusion in Table 3.12 (i.e., spiked bioassay data involving single measured contaminants). These studies are discussed below.

Nebeker et al. (1986a) spiked freshwater sediments and water with cadmium to determine if cadmium in the sediment would cause increased toxicity to the amphipod Hyalella azteca. Test exposures were 2.5, 5.0, 10, 20 and 40 mg cadmium added to 800 mL of water and 200 mL of sediment. Sediment cadmium concentrations were not reported. The 96-hour LC50 value for a test without sediment was 8 ug/L total cadmium; two ten-day LC50 values were less than 2.8 and 6.0 ug/L. For tests with sediment, the 96-hour LC50 values for total and soluble cadmium in water above the sediment were 74 and 6.6 ug/L, respectively. The ten-day LC50 for total vs. soluble cadmium in the test was 80 ug/L, similar to the 96-hour LC50 for total cadmium, indicating that little additional mortality occurred after 96 hours. The higher LC50 values for total cadmium indicate that much of the cadmium in tests with sediments is likely bound to particulate and soluble organic materials, making it unavailable to exert a toxic effect on the organisms.

As part of a series of laboratory studies on the role of contaminated sediment in the sublethal or lethal effects of trace metals in benthic macroinvertebrates, Wentsel et al.

(1977a) exposed chironomid larvae (Chironomus tentans) for 17 days to five sediments from Palestine Lake, Indiana, with varying concentrations of heavy metals. The control sediment had levels of 0.6 ug/g cadmium, 17 ug/g chromium and 77 ug/g zinc, whereas the two most contaminated sediments had levels up to 1,030 ug/g cadmium, 2,130 ug/g chromium and 17,300 ug/g zinc. Survival of the chironomid larvae ranged from 46% in the most contaminated sediment to 81% in the control sediment, with the difference in survival between the control and most contaminated sediment being statistically significant. In addition, the mean length and weight of the larvae from the control sediment were 1.83 cm and 2.86 mg, respectively. In contrast, the mean length and weight of larvae from the most contaminated sediment were only 0.82 cm and 0.20 mg, respectively. A linear relationship was found for the square root of length versus metal levels in the sediment, indicating that these metals are a likely cause for the inhibition of chironomid larvae development.

Sediments from the Phillips Chain of Lakes in Wisconsin were tested by Malueg et al. (1984b) for acute toxicity using the mayfly nymph Hexagenia limbata. None of the test sediment mortalities (6.7 to 13.3%) over the ten-day exposure were significantly different from the control (6.7%). The most contaminated test sediment contained 4.9 ug/g cadmium, 980 ug/g chromium, 540 ug/g copper, 9.4 ug/g mercury, 350 ug/g nickel, 160 ug/g lead and 570 ug/g zinc. Only chromium and copper were found in the overlying water in detectable amounts (maximum concentrations of 225 and 110 ug/L, respectively).

Magnuson et al. (1976) reported that concentrations of mercury between 0.6 and 3.0 ug/g in sediments affected the activity behaviour of the amphiod Pontoporeia affinis, with a decline in the number of active animals and decreased activity rates. In contrast, zinc concentrations between 58.5 and 123.5 ug/g in sediments did not cause a change in the numbers of active P. affinis; however, their rate of activity was significantly lower compared to controls.

A number of studies have demonstrated avoidance reactions of benthic invertebrates to contaminated sediments. For example, Wentsel et al. (1977b) established a linear relationship between cadmium and zinc concentrations in sediments and avoidance by the midge larva C. tentans. An approximate threshold avoidance of metals in the sediments was determined to be 213 to 422 ug/g of cadmium, 4,385 to 8,330 ug/g of zinc, and 799 to 1,513 ug/g of chromium. McMurtry (1984) reported an avoidance response of tubificid oligochaetes Tubifex tubifex and Limnodrilus hoffmeisteri to dosed Toronto Harbour sediment containing sublethal concentrations of copper (570 ug/g) and zinc (1,135 ug/g) alone, or copper (550 ug/g) and zinc (1,080 ug/g) in combination. The effect of copper and zinc in combination was not significantly greater than that of either metal alone.

As part of his avoidance studies, McMurtry (1982) conducted 96-hour static toxicity tests to determine concentrations of copper and zinc in sediment that caused no acute mortality to T. tubifex and L. hoffmeisteri, yet would elicit a sublethal avoidance response. Virtually complete survival (98 to 99%) of both species occurred in spiked sediments with concentrations of copper (655 ug/g) and zinc (1,300 ug/g) alone, or copper (625 ug/g) and zinc (1,360 ug/g) in combination. Copper concentrations (0.078 mg/L) in the water overlying the test sediments spiked with copper was below the 48-hour LC50 value of 0.89 mg/L copper for T. tubifex (Brkovic-Popovic and Popovic, 1977a). Zinc concentration (2.69 mg/L) in overlying water of the sediment zinc exposure was also below the 48-hour LC50 value of 60.2 mg/L zinc (Brkovic-Popovic and Popovic, 1977a). Copper (0.053 mg/L) and zinc (7.54 mg/L) concentrations in the water overlying sediment spiked with both copper and zinc were also below the respective LC50 values for T. tubifex.

Birge et al. (1977) evaluated the embryopathic effects of cadmium, mercury and zinc released from metal-enriched sediments on goldfish (Carassius auratus). Sediments were enriched with each metal at four enrichment levels starting at 0.1 ug/g and increasing at ten-fold intervals to 100 ug/g. Exposure was initiated after fertilization and maintained through four days post-hatching. Toxicity results are presented as frequency of percent mortality in the metal-enriched bioassays over that in the control bioassays. Percent mortality in the control was not given. For all test bioassays of spiked sediments, embryonic mortality was appreciably higher than for the controls. However, no relationship was evident between the frequency of percent mortality and increasing sediment metal concentration over the range tested.

LeGore and DesVoigne (1973) conducted static 96-hour bioassays exposing threespine sticklebacks (Gasterosteus aculeatus) to suspensions of sediment (doses of up to 5% wet weight) from the Duwamish Waterway, Seattle, Washington. No observable effect on the fish was observed. Metal concentrations in the sediments tested ranged from 0.04 to 0.13 ug/g mercury, 10 to 59 ug/g lead, 122 to 201 ug/g zinc, 27 to 30 ug/g nickel and 9,000 to 42,000 ug/g iron.

White (1984) and Keilty (1987) reported on preliminary results of acute and chronic toxicity of a number of organic contaminants in sediments on oligochaete worms. Based on 96-hour toxicity tests, Stylodrilus heringianus, L. hoffmeisteri and Potamothrix vejdovskyi showed no mortality in sediment spiked with concentrations of 2,4,5,2',4',5'-hexachlorobiphenyl (HCBP) up to 1,000 ug/g. Data analysis of sediment reworking rates showed no significant differences between the control and test sediments spiked with HCBP concentrations of 90, 142, 223, 500, 989 and 1,200 ug/g.

Keilty (1987) also conducted 96-hour exposure tests on S. heringianus to aldrin, p,p-DDT, chlordane, endrin and mirex at concentrations of 0.005 and 1,000 ug/g in sediments. At the low concentration, percent survival after 96 hours was 40% for mirex, 60% for chlordane, 70% for p,p-DDT, and 100% for aldrin or endrin. At the high concentration, percent survival was 0% for chlordane, 30% for mirex, 40% for endrin, and 50% for p,p-DDT and aldrin.

Based on the dose-response data presented in Table 3.12 as well as the bioassay data discussed above, tentative sediment quality guidelines have been developed. These guidelines are presented and compared to regulatory guidelines in Table 3.13. The tentative guideline values for cadmium, mercury and zinc can be considered to be conservative as they are based on seven-day embryo-larval exposures of rainbow trout, Salmo gairdneri (the most sensitive life-stage of a sensitive fish species).

For copper, the ten-day LC50 value of 857 ug/g for Chironomus tentans exposure with a safety factor of 0.1 was used as the basis of tentative guideline development. The application factor of 0.1 was derived from water quality criteria development data sets that suggest that lethal thresholds are approximately 0.5 of the LC50 values. An extensive evaluation of sublethal data by Mayer et al. (1986) indicated that 0.2 of the threshold lethal concentration provides a good estimate of NOEC (no observed effects concentration) values. The product of the two values (0.5 x 0.2) provides the 0.1 factor.

For chromium, the value of 980 ug/g, reported by Malueg et al. (1984b) as a maximum concentration at which mortality of Hexagenia limbata was not significantly different from the control, was used as the basis of tentative guideline development, followed by application of a safety factor of 0.1.

For endrin, the 96-hour avoidance EC50 value of 17 ug/g for Stylodrilus heringianus with a safety factor of 0.1 was used as the basis of tentative guideline development. In this case, a safety factor of 0.1 was applied to account for the short test duration. Mackay et al. (1987) have suggested an order of magnitude adjustment to shift from acute to chronic protection.

The tentative guideline values for cadmium and zinc based on the bioassay approach were two times higher than the regulatory values. The tentative guideline value for chromium was four times higher than the MOE and U.S. EPA guidelines and the same as the WDNR guideline. The tentative guideline value for copper was higher than the MOE and U.S. EPA guidelines, but lower than the WDNR guideline. The tentative guideline value for mercury was the same as the U.S. EPA guideline value, and above the MOE and WDNR guidelines. Finally, the tentative guideline for endrin was 50 times higher than the WDNR guideline, probably due to extreme tolerance of the oligochaete species tested.

Application of the bioassay approach in development of sediment quality guidelines is currently limited by availability of data, particularly for chronic test endpoints and sensitive life stages.

TABLE 3.1: MEAN AND MAXIMUM BACKGROUND METAL CONCENTRATIONS

Metal	N	Concentration (ug/g unless otherwise indicated) Mean	Minimum	Maximum	S.D.	95% Upper Confidence Limit[2]
Arsenic	7	4.2	0.6	11.5	4.0	12
Cadmium	36	1.1	0.1	3.2	0.7	2.5
Chromium	36	31	1	75	22	77
Copper	42	25	3	80	19	63
Iron (%)	27	3.12	1.10	5.66	1.36	5.92
Lead	37	23	5	90	16	56
Manganese (%)	23	0.04	0.004	0.15	0.04	0.12
Mercury[1]	24	0.10	0.04	0.69	-	0.61
Nickel	35	31	6	89	21	73
Zinc	42	65	5	210	39	143

[1] Geometric mean and 95% upper confidence limit.

[2] Mean + $t_{.05}$ SD; 90% upper confidence limit for arsenic.

TABLE 3.2: PROPOSED SEDIMENT QUALITY GUIDELINES FOR METALS BASED ON BACKGROUND APPROACH OF THIS STUDY COMPARED TO REGULATORY GUIDELINES

	Concentration (ug/g unless otherwise indicated)			
Metal	Proposed Guideline[1]	MOE[2]	U.S. EPA Region V[3]	WDNR[4]
Arsenic	12	8	3	10
Cadmium	2.5	1	-	1
Chromium	75	25	25	100
Copper	65	25	25	100
Iron (%)	5.9	1	1.7	-
Lead	55	50	40	50
Manganese (%)	0.12	-	0.03	-
Mercury	0.6	0.3	1	0.1
Nickel	75	25	20	100
Zinc	145	100	90	100

[1] This study; values based on 95% upper confidence limit, except for arsenic, which is based on 90% upper confidence limit; some limit values rounded slightly.

[2] Open water dredge spoil disposal guidelines (Persaud and Wilkins, 1976).

[3] Guidelines for the pollutional classification of Great Lakes harbour sediments (U.S. EPA, 1977).

[4] Wisconsin Department of Natural Resources interim criteria and guidance criteria for in-water disposal of dredge material (Sullivan et al., 1985).

TABLE 3.3: BACKGROUND METAL CONCENTRATIONS IN GREAT LAKES SEDIMENTS BASED ON OTHER APPROACHES

	Concentration (ug/g unless otherwise indicated)						
	Bluffs Materials			'Undeveloped' Great Lakes	Pleistocene	Michigan 'Non-contaminated'	Proposed
Metal	L. Ontario[1]	L. Erie[1]	L. Superior[2]	River Mouths[3]	Lake Sediments[4]	Surficial Sediments[5]	Guideline[6]
Arsenic	2.7	5.7	9.9	-	10.7	2	12
Cadmium	1.2	1.2	-	1.7	-	11	2.5
Chromium	25	36	88	16	27	4	75
Copper	23	23	30	21	23	-	65
Iron (%)	2.21	2.21	4.54	-	3.22	-	5.9
Lead	19	22	-	28	21	99	55
Manganese (%)	0.051	0.051	-	0.045	0.060	-	0.12
Mercury	0.03	0.02	0.02	0.12	0.08	0.29	0.6
Nickel	16	17	-	28	22	-	75
Zinc	41	49	110	118	73	53	145

[1] Based on an overall mean of mean values reported by Kemp and Dell (1976) and Boyd (1988); see Appendix Table A-11 for specific data.

[2] Based on Helmke et al. (1976).

[3] Based on Fitchko and Hutchinson (1975).

[4] Based on Frye and Shimp (1973).

[5] Based on Hesse and Evans (1972).

[6] This study; values based on 95% upper confidence limit, or 90% upper confidence limit for arsenic; some limit values rounded.

TABLE 3.4: PROPOSED SEDIMENT QUALITY GUIDELINES FOR ORGANICS BASED ON THE CONTEMPORARY BENCHMARK APPROACH OF THIS STUDY COMPARED TO REGULATORY GUIDELINES

	Concentration (ug/g)			
Organic	Proposed Guideline[1]	MOE	U.S. EPA Region V	WDNR
Aldrin	0.001	-	-	0.01
α-BHC	0.001	-	-	-
β-BHC	0.001	-	-	-
γ-BHC	0.001	-	-	0.05
α-Chlordane	0.001	-	-	-
γ-Chlordane	0.001	-	-	-
oxy-Chlordane	0.001	-	-	-
Chlordane	0.001	-	-	0.01
o,p-DDT	0.001	-	-	-
p,p-DDD	0.002	-	-	-
p,p-DDE	0.003	-	-	-
p,p-DDT	0.005	-	-	-
Total DDT	0.01	-	-	0.01
Dieldrin	0.001	-	-	0.01
Endrin	0.001	-	-	0.05
HCB	0.001	-	-	-
Heptachlor	0.001	-	-	0.05
Heptachlor Epoxide	0.001	-	-	-
Mirex	0.001	-	-	-
Total PCB	0.02	0.05	10	0.05

[1] Highest of Lake Huron or Lake Superior mean (Glooschenko et al., 1976; Frank et al., 1979b).

TABLE 3.5: SUMMARY OF LOG$_{10}$ K$_{ow}$ VALUES, AS TABULATED BY BATTELLE (1988) OR AS GIVEN IN THE MONTANA STATE UNIVERSITY QSAR DATABASE (Values for compounds not given in these sources are taken from the U.S. EPA (1979) and Kadeg et al. (1986))

Compound	Log$_{10}$ K$_{ow}$ Measured	Calculated From Fragment Analysis	Calculated From Aqueous Solubility	Pavlou geometric mean (95% CI)	U.S. EPA (1979)	Kadeg et al. (1986) geometric mean
Aldrin	-	-	-			6.12
α-BHC	-	3.75	-			
β-BHC	-	3.75	-			
γ-BHC	3.72	3.75	3.41	3.35 (3.23-3.47)		
α-Chlordane						
γ-Chlordane						
Oxychlordane						
Chlordane	-	5.54	4.76	4.01 (3.05-4.97)		
o,p-DDT						
p,p-DDT					6.19; 3.98	
p,p-DDE					5.69	5.60
DDT	6.37	6.91	6.16	6.02 (5.73-6.31)		
Dieldrin	4.32	2.92	4.40	4.92 (3.96-5.88)		
Endrin	-	2.92	3.81	4.44 (3.74-5.14)		
Hexachlorobenzene	-	6.42	-			
Heptachlor	-	4.61	5.18	4.54 (3.89-5.19)		
Heptachlor Epoxide						
Mirex						
PCBs						
Aroclor -1254	6.73	-	-	6.25 (5.87-6.63)		
Aroclor -1016	-	-	-		4.38; GT 5.58	4.30-5.48
Aroclor -1221	-	-	-		4.09; 2.8	2.78-4.00
Aroclor -1232	-	-	-		3.2; GT 4.54	3.18-4.48
Aroclor -1242	6.10	-	-			4.00-5.60
Aroclor -1248	-	-	-		5.75; GT 6.11	6.00
Aroclor -1260	6.94	-	-			
Aroclor -1262	-	-	-			

TABLE 3.6: LOG K_{ow} VALUES (FROM TABLE 3.5) AND CALCULATED K_{oc} VALUES FOR ORGANIC CONTAMINANTS

	Log K_{ow}			Log K_{oc}		
Compound	Mean	S.D.	95% CI	Mean	S.D.	95% CI
Aldrin	6.12	-	-	6.02	-	-
α-BHC	3.75	-	-	3.69		
β-BHC	3.75	-	-	3.69		
γ-BHC	3.35	0.063	3.23-3.47	3.29	0.306	2.69-3.90
α-Chlordane						
γ-Chlordane						
Oxychlordane						
Chlordane	4.01	0.487	3.05-4.97	3.94	0.572	2.99-4.89
o,p-DDT						
p,p-DDT	4.96*	-	-	4.88	-	-
p,p-DDE	5.69	-	-	5.59	-	-
DDT	6.02	0.1479	5.73-6.31	5.92	0.334	5.26-6.58
Dieldrin	4.92	0.490	3.96-5.88	4.84	0.574	3.71-5.97
Endrin	4.44	0.355	3.74-5.14	4.36	0.465	3.45-5.29
Hexachlorobenzene	6.42	-	-	6.31	-	-
Heptachlor	4.54	0.329	3.89-5.19	4.46	0.445	3.59-5.34
Heptachlor Epoxide						
Mirex						
PCBs						
Aroclor 1254	6.25	0.196	5.87-6.63	6.14	0.358	5.44-6.85
Aroclor 1016	4.85*	-	-	GT 4.77	-	-
Aroclor 1221	3.38*	-	-	3.32	-	-
Aroclor 1232	GT 3.81*	-	-	3.75	-	-
Aroclor 1242	6.10	-	-	6.00	-	-
Aroclor 1248	GT 5.92*	-	-	GT 5.82	-	-
Aroclor 1260	6.94	-	-	6.82	-	-
Aroclor 1262	-	-	-	-	-	-

* Geometric mean computed in this study from values in U.S. EPA (1979) or Kadeg _et al._ (1986).

TABLE 3.7: SEDIMENT QUALITY GUIDELINES FOR ORGANIC COMPOUNDS HAVING PROVINCIAL WATER QUALITY OBJECTIVES, BASED ON EQUILIBRIUM PARTITIONING

	PWQO	log K_{oc}	Sediment Quality Guideline (ug/g C)	
Compound	(ug/L)	(95% CI)	Mean	(95% CI)
Aldrin	0.001	6.02	1.05	
γ-BHC	0.01	3.29 (2.69-3.90)	0.0195	(0.0049-0.0794)
Chlordane	0.06	3.94 (2.99-4.89)	0.523	(0.0586-4.66)
DDT (total)	0.003	5.92 (5.26-6.58)	2.50	(0.550-11.4)
Dieldrin	0.001	4.84 (3.71-5.97)	0.062	(0.0051-0.933)
Endrin	0.002	4.36 (3.45-5.29)	0.0458	(0.0056-0.39)
Hexachlorobenzene	0.0007*	6.31	1.43	
Heptachlor[1]	0.001	4.46 (3.59-5.34)	0.0288	(0.0039-0.2188)
PCBs	0.001	6.14 (5.44-6.85) (Aroclor 1254)	1.38	(0.275-7.07)

* Recommended PWQO (McCarty *et al.*, 1983).

[1] PWQO for heptachlor plus heptachlor epoxide; K_{oc} for heptachlor.

TABLE 3.8: SEDIMENT QUALITY GUIDELINES FOR ORGANIC COMPOUNDS HAVING U.S. EPA WATER QUALITY CRITERIA

	Water Quality Criterion (ug/L)		log K_{oc}	Sediment Quality Guideline (95% CI) (ug/g C)	
Compound	FCV[1]	FRV[1]	(95% CI)	FCV	FRV
Chlordane	0.17	0.0043	3.94 (2.99-4.89)	1.48 (0.166-13.20)	0.0375 (0.0042-0.334)
DDT	-	0.001*	5.92 (5.26-6.58)	-	0.828 (0.183-3.80)
Dieldrin	0.29	0.0019	4.84 (3.71-5.97)	19.9 (1.49-2.73)	0.130 (0.00976-1.79)
Endrin	0.045	0.0023	4.36 (3.45-5.29)	1.04 (0.128-8.68)	0.0532 (0.00654-0.443)
Heptachlor	-	0.0038	4.46 (3.59-5.34)	-	0.110 (0.0148-0.840)
PCB	-	0.014*	6.14 (5.44-6.85)	-	19.5 (3.87-99.9)

FCV: final chronic value - lowest concentration known to elicit a chronic response in freshwater biota.

FRV: final residue value - concentration resulting in highest permissible tissue concentration for human consumption.

* FRV values for the protection of sensitive wildlife.

TABLE 3.9: SEDIMENT QUALITY GUIDELINES FOR ORGANIC COMPOUNDS HAVING PROVINCIAL OR CANADIAN FEDERAL RESIDUE LIMITS, BASED ON EQUILIBRIUM PARTITIONING

Compound	Tissue Criterion (ug/g)	BCF[1]	FRV (ug/L)	log K_{oc} (95% CI)	Sediment Quality Guideline (ug/g C) Mean	Sediment Quality Guideline (ug/g C) (95% CI)
Chlordane	0.015	70,530	0.00021	3.94 (2.99-4.89)	0.0018	(0.0002-0.0163)
DDT	5*	268,050	0.01865	5.92 (5.26-6.58)	15.51	(2.0-70.9)
Dieldrin	0.03	23,355	0.00128	4.84 (3.71-5.97)	0.0886	(0.006-1.195)
Endrin	0.015	19,860	0.00076	4.36 (3.45-5.29)	0.0174	(0.002-0.148)
Heptachlor	0.03	78,330	0.00038	4.46 (3.59-5.34)	0.0109	(0.001-0.083)
PCB	2*	156,000	0.01282	6.14 (5.44-6.85)	17.69	(3.5-90.7)

* DDT and PCB tissue criteria for edible fish (MOE/MNR, 1988; HW, 1987).

NB. Other tissue criteria derived from HW (1987) guideline for fat content of meat, multiplied by an assumed fat fraction of 0.15.

[1] BCF values from EPA (1980) ambient water quality criteria documents.

TABLE 3.10: APPARENT EFFECTS THRESHOLD (AET) VALUES COMPARED TO EXISTING REGULATORY GUIDELINES

	AET Data Subset (ug/g)			Guideline Concentration (ug/g)			
Contaminant[1]	All Data	% Survival Only	*Hexagenia* Survival	Proposed[2]	MOE	U.S. EPA Region V	WDNR
Chromium	980	980	-	-	25	25	100
Copper	1,800	1,100	860	86	25	25	100
Iron (%)	9.6	9.6	-	-	1	1.7	-
Lead	330	330	200	20	50	40	50
Zinc	4,400	1,900	920	92	100	90	100
Heptachlor	0.08	0.08	-	-	-	-	0.05
Endrin	0.005 (L 0.03)	0.005 L 0.03)	-	-	-	-	0.05
Mirex	L 0.05	L 0.05	-	-	-	-	-
Aldrin	L 0.01	L 0.01	-	-	-	-	0.01
Chlordane	0.008 (L 0.1)	0.008 (L 0.1)	-	-	-	-	0.01
p,p-DDT	0.3	0.3	-	-	-	-	-
p,p-DDD	L 0.02	L 0.02	-	-	-	-	-
PCB 1254	0.07	0.07	-	-	-	-	-
PCB 1248	0.43	0.43	-	-	-	-	-
PCB 1016	2.3	2.3	-	-	-	-	-

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[1] AET values for other contaminants were not calculable due to insignificant effects at highest concentrations tested.
[2] Proposed guideline based on *Hexagenia* AET divided by 10 to adjust from acute to chronic protection level.

TABLE 3.11: SCREENING LEVEL CONCENTRATION (SLC) VALUES COMPARED TO EXISTING REGULATORY GUIDELINES

	Screening Level Concentration			Existing Guideline (ug/g)		
Contaminant	Bulk (ug/g)	Normalized by TOC (ug/g C)	X 0.04 (ug/g)	MOE[1]	U.S. EPA Region V[2]	WDNR[3]
Arsenic	5.5**	980**	39	8	3	10
Cadmium	0.59	89	3.5	1	-	1
Chromium	21.6	3,370	134	25	25	100
Copper	15.4	2,320	93	25	25	100
Iron (%)	2.1	*	-	1	1.7	-
Lead	30.7	2,940	118	50	40	50
Manganese	457	27,700	1,108	-	30	-
Mercury	0.12	11	0.44	0.3	1	0.1
Nickel	15.0	2,290	92	25	20	100
Zinc	110	14,080	563	100	90	100
Heptachlor	0.0005	0.2	0.008	-	-	0.05
Endrin	0.01	0.3	0.012	-	-	0.05
Mirex	0.003	0.7	0.028	-	-	-
Aldrin	0.0005	0.2	0.008	-	-	0.01
Chlordane	0.003	0.75	0.03	-	-	0.01
p,p-DDT	0.006	0.9	0.036	-	-	-
p,p-DDD	0.01	0.8	0.032	-	-	-
p,p-DDE	0.002	0.5	0.02	-	-	-
o,p-DDT	0.004	0.6	0.024	-	-	-
PCB 1254	0.393	5.8	0.23	-	-	-
PCB 1248	0.145	3.4	0.14	-	-	-
PCB 1016	0.026	0.7	0.03	-	-	-
PCB's	0.143**	16.4**	0.65	0.05	10	0.05
Dieldrin	0.009	1.9	0.076	-	-	0.01
BHC	0.001	0.32	0.013	-	-	-
σ-BHC	0.003	0.3	0.012	-	-	0.05
β-BHC	0.005	0.5	0.02	-	-	-
α-BHC	0.003	0.6	0.024	-	-	-
HCB	0.009	2.0	0.08	-	-	-
Heptachlor Epoxide	0.014	0.45	0.018	-	-	-
σ-Chlordane	0.005	0.5	0.02	-	-	-

[1] Open water dredge spoil disposal guidelines (Persaud and Wilkins, 1976).

[2] Guidelines for the pollutional classification of Great Lakes harbour sediments (U.S. EPA, 1977).

[3] Wisconsin Department of Natural Resources interim criteria and guidance criteria for in-water disposal of dredge materials (Sullivan et al., 1985).

* TOC-normalized SLC for iron greater than g/g.

** Based on MOE In-Place Pollutants data, TOC-normalized SLCs for arsenic and PCBs are 437 and 4.1 ug/g C, respectively. Bulk values are 5.5 and 0.029 ug/g, respectively.

TABLE 3.12: DOSE-RESPONSE DATA BASED ON THE BIOASSAY APPROACH

Contaminant	Organism	Type of Test	Dose-Response Sediment Concentration (ug/g)	Reference
Cadmium	Rana pipiens	7-d embryo-larval TL50[1]	GT 1,000[2]	Francis et al. (1984)
	Carassius auratus	7-d embryo-larval TL50	GT 1,000[2]	Francis et al. (1984)
	Micropterus salmoides	7-d embryo-larval TL50	GT 100 L 1,000[2]	Francis et al. (1984)
	Salmo gairdneri	7-d embryo-larval TL50	2.15	Birge et al. (1977)
Copper	Chironomus tentans	10-d LC50	2,296	Cairns et al. (1984)
	C. tentans	10-d LC50	857	Cairns et al. (1984)
	C. decorus	72-hr LC50	5,830[3]	Kosalwat and Knight (1987a)
	C. decorus	14-d EC50[4]	1,602[3]	Kosalwat and Knight (1987b)
	C. decorus	12-d % deformities	GT 26 L 896[2,3]	Kosalwat and Knight (1987b)
	C. decorus	time to adult emergence	GT 1,797 L 2,643[2,3]	Kosalwat and Knight (1987b)
	Gammarus lacustris	10-d LC50	964	Cairns et al. (1984)
	Hyalella azteca	10-d LC50	1,087	Cairns et al. (1984)
	Hexagenia limbata	10-d survival	GT 930[2]	Malueg et al. (1984a)
	H. limbata	10-d survival	GT 200 L 550[2]	Malueg et al. (1984b)
Mercury	Salmo gairdneri	7-d embryo-larval TL50	1.0	Birge et al. (1977)
	Pontoporeia affinis	5-d survival	GT 3.35	Magnuson et al. (1976)
Zinc	Salmo gairdneri	7-d embryo-larval TL50	210.6	Birge et al. (1977)
	Pontoporeia affinis	5-d survival	GT 123.5	Magnuson et al. (1976)
Endrin	Stylodrilus heringianus	96-hr LC50	2,588	Keilty et al. (1988)
	S. heringianus	96-hr burrowing avoidance EC50	17	Keilty et al. (1988)
	Limnodrilus hoffmeisteri	96-hr LC50	2,725	Keilty et al. (1988)
	L. hoffmeisteri	96-hr burrowing avoidance EC50	59	Keilty et al. (1988)

[1] TL50 = the substrate concentration at which 50% of test organisms survive for a specified period of time (i.e., LC50).

[2] Statistically different from control or lowest concentration exposures.

[3] Based on copper-spiked Cerophyl substrate (ground dehydrated unjointed rye cereal and grass leaves).

[4] EC50 = the substrate concentration that reduced larval growth by 50%.

GT - greater than.

L - less than.

TABLE 3.13: TENTATIVE SEDIMENT QUALITY GUIDELINES BASED ON BIOASSAY APPROACH

Parameter	Guideline[1]	MOE[2]	U.S. EPA Region V[3]	WDNR[4]
Cadmium	2	1	-	1
Chromium	100[5]	25	25	100
Copper	85	25	25	100
Mercury	1	0.3	1	0.1
Zinc	210	100	90	100
Endrin	1.7	-	-	0.05

[1] This study; see text for guideline value development description.

[2] Open water dredge spoil disposal guidelines (Persaud and Wilkins, 1976).

[3] Guidelines for the pollutional classification of Great Lakes harbour sediments (U.S. EPA, 1977).

[4] Wisconsin Department of Natural Resources interim criteria and guidance criteria for in-water disposal of dredge material (Sullivan et al., 1985).

[5] Based on field bioassay data (Malueg et al., 1984b).

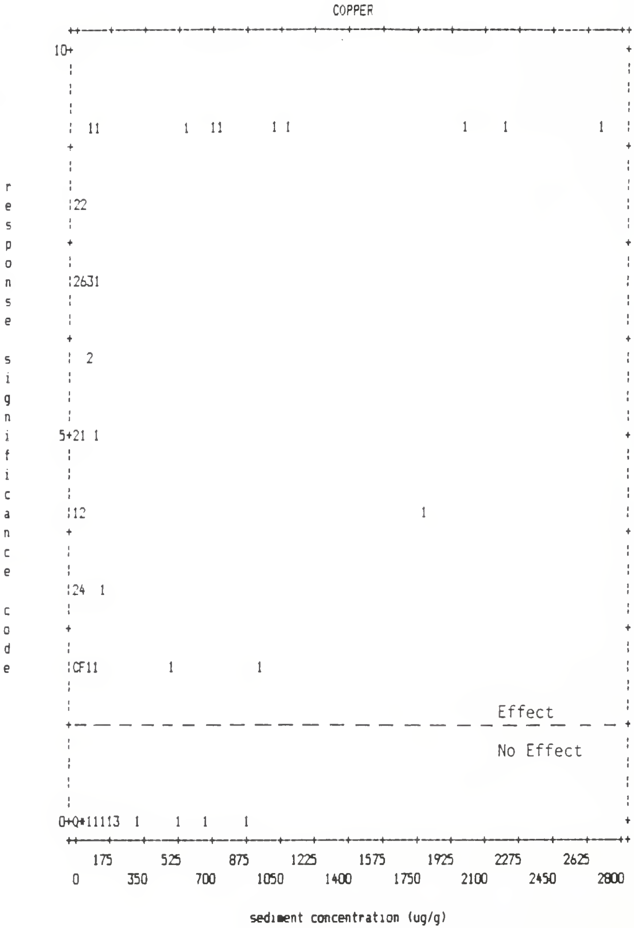

FIGURE 3.1: HEXAGENIA AET PLOT FOR COPPER IN BULK SEDIMENT (plot symbols indicate number of observations, C = 30-39, F = 60-69, Q = 170-179)

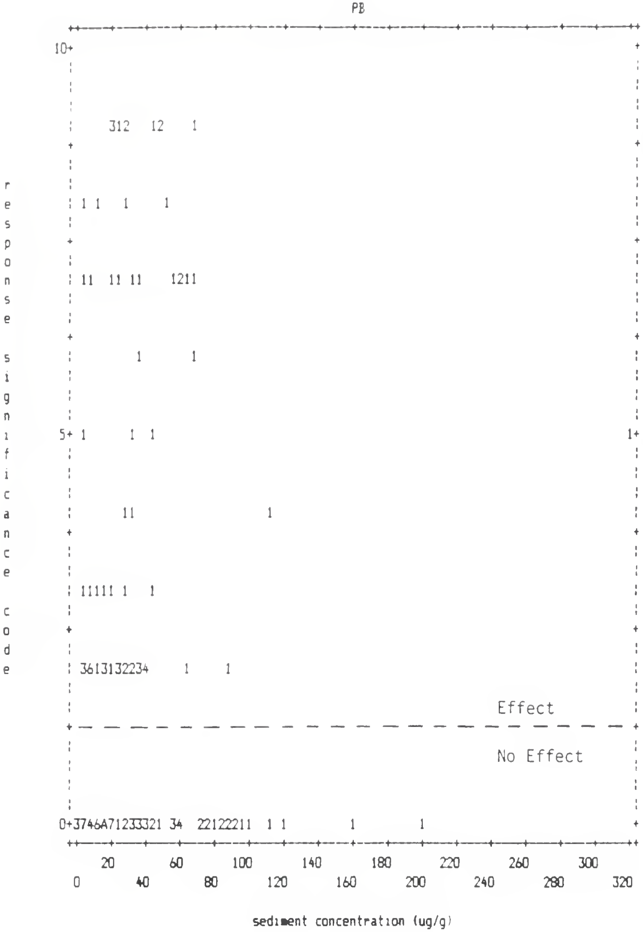

FIGURE 3.2: HEXAGENIA AET PLOT FOR LEAD IN BULK SEDIMENT
(plot symbols indicate number of observations, A = 10-19)

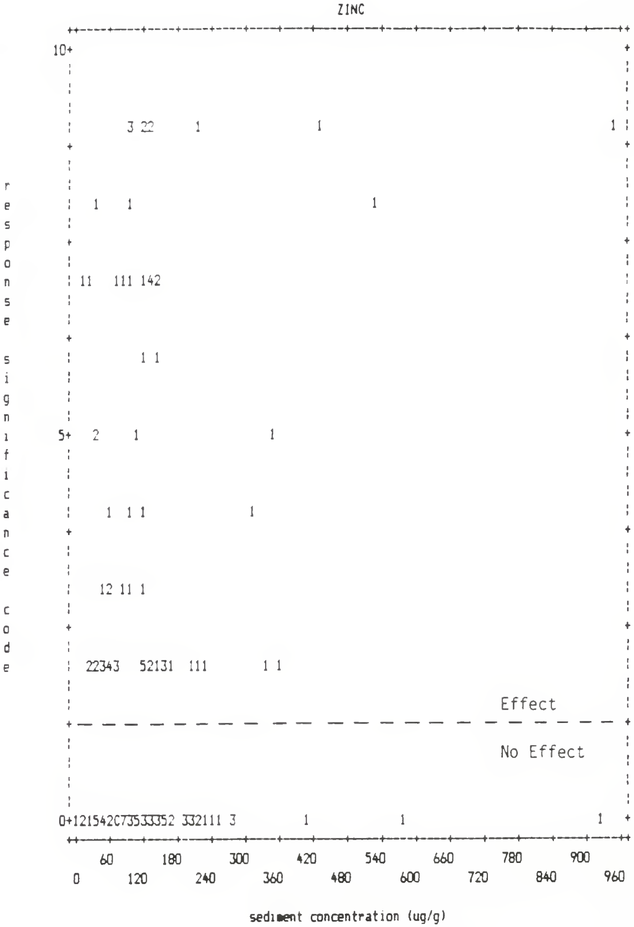

FIGURE 3.3: HEXAGENIA AET PLOT FOR ZINC IN BULK SEDIMENT (plot symbols indicate number of observations, C = 30-39)

4.0 COMPARISON OF APPROACHES

Sediment quality guidelines derived by six different approaches are compared in Table 4.1. In comparing approaches, all guidelines have been rounded to two significant figures, and expressed on a bulk sediment basis.

The approaches compared in Table 4.1 differ both in level of environmental protection intended and in strength of supporting rationale. The strength of a rationale is considered here to lie in its biological basis, and the soundness of the link to unacceptable biological effects above the guideline concentration.

The background approach has no biological basis. Nevertheless, background limits are important from an enforcement perspective. While it is possible to observe biological effects in some species at metal concentrations indistinguishable from non-anthropogenic background, it is difficult to justify enforcement of a standard that has never been realized in nature. Thus, background limits for metals provide a practical lower bound on the criterion selection process. For organic contaminants, which are entirely anthropogenic, a contemporary benchmark based on current upper Great Lakes means may provide a similar practical lower bound for enforcement.

Generic partitioning approaches are biologically based to the extent that existing water or tissue criteria are biologically based, and therefore provide more defensible guidelines than the background approach. In practice, due to present uncertainties in application of partitioning methods to metals, and the lack of true background limits for organics, it is not necessary to choose between partitioning and background approaches. For some organic contaminants, the contemporary benchmark and partitioning approaches can be compared, after adjustment of partitioning values to a bulk sediment basis. Partitioning values are higher for total DDT, PCB (FRV approach) and chlordane (PWQO approach). Other partitioning values are lower than benchmark on a bulk sediment basis.

The AET and SLC approaches are both directly effects-based and, therefore, more defensible than the partitioning approaches. Nevertheless, there are assumptions involved (i.e., that effects observed above the AET concentration are related to the contaminant of interest, or that concentrations in the SLC database span the full tolerance range of the species represented). Consequently, these methods are less defensible than the spiked bioassay method.

There is a paucity of chronic effects data suitable for AET applications, particularly if consistency in level of protection (i.e., single species and endpoint) is desired. Consequently, a very approximate correction factor is applied here, to adjust from acute to chronic protection. This necessity makes the AET approach somewhat less defensible than the SLC approach in this study although, with further chronic data acquisition, the two approaches could be considered equally defensible. There is currently abundant data for Great Lakes application of the SLC approach.

With adjustment from an acute to chronic protection level, Hexagenia AETs for metals are very close to the upper background limits (slightly above for copper, slightly below for lead and zinc). The SLC guideline for copper is almost identical to the adjusted Hexagenia AET but, for lead and zinc, the SLC is approximately five times higher. These differences for lead and zinc may be due to TOC-normalization in SLC computation, since SLCs computed from bulk data agree with the adjusted Hexagenia AETs for these metals. DiToro et al. (1987) have devised a normalization procedure which may better represent metal availability, based on TOC, Fe and Mn oxides, and porosity. Extraction procedures prior to chemical analysis might also provide improved measures of available metal; however, guidelines based on such measures would require extraction to determine compliance.

In general, SLC guidelines for metals are slightly higher than the upper background limits (slightly lower for manganese and mercury). The SLC guidelines for organic pesticides and PCBs are slightly higher, in general, than the sediment-water partitioning guidelines (slightly lower for chlordane). Overall, the various methods agree within an order of magnitude.

The spiked bioassay approach is most defensible, since the observed effects are known without doubt to be caused by the contaminant of interest. However, due to the paucity of spiked bioassay data, it is difficult to achieve consistency in level of protection (i.e., a variety of species and endpoints must be considered). This problem could be rectified with further chronic data acquisition, particularly if standard spiking techniques were adopted. After adjustment of acute endpoints to represent a chronic protection level, the spiked bioassay guidelines, with one exception, are within an order of magnitude of other sediment guidelines for the same toxic substances. The exception is an acute test exposing tubificid oligochaetes to endrin. Such a tolerant organism probably should not be the basis of a sediment quality guideline.

TABLE 4.1: COMPARISON OF PROPOSED SEDIMENT QUALITY GUIDELINES (ug/g) BASED ON DIFFERENT METHODS

		Generic Partitioning				
Contaminant	Background Limit[1]	Sed.-Water[2]	Sed.-Wat.-Biota[2]	Hexagenia AET	Benthic SLC[2]	Spiked Bioassay
As	12	-	-	-	17*	-
Cd	2.5	-	-	-	3.5	2
Cr	75	-	-	-	134	100
Cu	65	-	-	86	93	85
Fe (%)	5.9	-	-	-	-	-
Pb	55	-	-	20	118	-
Mn (%)	0.12	-	-	-	0.11	-
Hg	0.6	-	-	-	0.44	1
Ni	75	-	-	-	92	-
Zn	145	-	-	92	563	210
Heptachlor	0.001	L 0.001	L 0.001	-	0.008	-
Endrin	0.001	L 0.001	L 0.001	-	0.012	1.7
Mirex	0.001	-	-	-	0.028	-
Aldrin	0.001	-	-	-	0.008	-
Chlordane	0.001	0.002	L 0.001	-	0.03	-
DDT (total)	0.001	0.02	0.08	-	-	-
p,p-DDT	0.005	-	-	-	0.036	-
p,p-DDD	0.002	-	-	-	0.032	-
p,p-DDE	0.003	-	-	-	0.02	-
o,p-DDT	L 0.001	-	-	-	0.024	-
PCB 1254	-	-	-	-	0.23	-
PCB 1248	-	-	-	-	0.14	-
PCB 1016	-	-	-	-	0.03	-
PCBs	0.02	0.01	0.14	-	0.16*	-
Dieldrin	0.001	L 0.001	-	-	0.076	-
BHC	-	-	-	-	0.013	-
γ-BHC	0.001	-	-	-	0.012	-
β-BHC	0.001	-	-	-	0.02	-
α-BHC	0.001	-	-	-	0.024	-
HCB	0.001	-	-	-	0.08	-
Heptachlor Epoxide	0.001	-	-	-	0.018	-
γ-chlordane	0.001	-	-	-	0.002	-

[1] Background limit for metals is upper confidence limit of pre-industrial concentration over all lakes, with some rounding; for organics, it is the highest of the Lake Superior or Lake Huron contemporary surficial sediment means.

[2] Based on TOC-normalized sediment concentrations and adjusted to bulk sediment basis assuming an average 4% total organic carbon.

* Indicates SLC based on MOE In-Place Pollutants data.

5.0 SELECTION OF CRITERIA

In accordance with the merits of the various approaches to guideline development, as discussed in Section 4.0, a tiered system is recommended for selection of a final sediment quality guideline for each chemical. This system would give preference to effects-based values, in a stepwise procedure:

1. select the lowest of the effects-based guidelines (chronic Hexagenia AET, SLC, spiked bioassay) if any of these can be calculated.
2. if this value is below the upper background limit, then use the background limit as the sediment quality guideline; and
3. if there is no effects-based guideline, then use the lowest generic partitioning value (if one exists above background), or the background limit otherwise.

The rationale for this procedure is that effects-based methods are more defensible than partitioning methods, and partitioning methods are more defensible than background methods. Partitioning is only indirectly effects-based, to the extent that the water or tissue quality criterion is effects-based, while the background methods are not based on biological effects at all.

Following this selection procedure, the recommended sediment quality guidelines in Table 5.1 are obtained. Most of the metal guidelines are based on background limits which exceed the lowest effects-based limit, while most of organic guidelines are based on the SLC approach. The SLC may underestimate the chronic effects threshold for some organic chemicals where the database may not cover the full tolerance range of all species represented. However, this error, if any, is conservative.

The rationale for a selected sediment quality guideline should include an outline of this selection process, in addition to a detailed description of the approach used to derive the selected value. For example, the rationale for a background limit would begin with a list of effects-based approaches which gave guidelines below the background limit, as a justification for selecting the background approach, followed by a description of the background limit derivation as the upper 95% confidence limit of background values from specified literature sources. Similarly, the rationale for an SLC guideline would list the effects-based approaches considered, identify the SLC value as the lowest, describe the SLC as an estimate of the concentration that 95% of the species considered could tolerate, and list the intolerant species in the 0-5 percentile range.

The selected sediment quality guidelines should be identified as interim values, based on available data at the time, and subject to revision as new data accumulate. Subsequent revisions should follow the same logical selection process, though using an expanded database, in order to maintain a consistent rationale.

The guidelines selected in Table 5.1 are intended to provide chronic protection of the environment, in the sense that sediment contamination above these limits should not be permitted, and loadings should be controlled to prevent exceedence of these limits. However, many harbour areas around the Great Lakes will already exceed these limits as a result of historical contamination. It is doubtful whether resources are sufficient to permit sediment excavation and confined disposal in all these areas. It may, therefore, be desirable to define two sets of criteria, one for chronic protection, and another for acute protection. Acute criteria might be used to identify priority sites for remediation (i.e., "cleanup criteria").

A simple procedure for defining an acute protection level would be to:

- multiply the criterion for chronic protection by 10 to provide a default value; and
- override the default with any lower acute effects threshold (i.e., the lowest acute AET or spiked bioassay).

Cleanup criteria could then be defined for metals as follows:

	ug/g
arsenic	170
cadmium	25
chromium	1,000
copper	850
iron	96,000

lead	200
manganese	12,000
mercury	6
nickel	920
zinc	920

The criterion for iron is based on a survival AET which was derived using multiple species data (Table 3.10), which overrides the default value of 59%; single species toxicity data are needed.

For organic pesticides and PCBs, cleanup criteria would all assume their default values at the present time. Cleanup criteria should not be used to preclude remedial options at sites with sediment concentrations between sediment quality guidelines and cleanup criteria, but rather to identify sites at which remediation is a high priority.

A strategy for application of sediment quality guidelines and cleanup criteria must define the actions to be taken when guidelines or criteria are exceeded. The following strategy is recommended:

- if sediment quality guidelines (for chronic protection) are exceeded, chronic toxicity testing of sediments would be undertaken to confirm and more clearly define the possibility and extent of biological impact;
- if these impacts are considered unacceptable, then cleanup in the impact zone may be required; and
- if cleanup criteria (for acute protection) are exceeded, cleanup action would be required.

This strategy would concentrate cleanup activity where it is most needed, and would also serve to expand the chronic toxicity database in the concentration range near the no-effect levels where toxicity test data are most needed.

5.1 Data Requirements

The process of guideline selection outlined above is based on the relative merits of the different approaches to guideline development. Their relative merits depend to some extent on the qualtiy of the database utilized in each approach. In designing the guideline selection process, we have assumed that suitable data are available for each approach utilized. Minimum data requirments for each approach may be summarized as follows:

- **Background** - at least 20 observations of pre-industrial contaminant concentrations in sediments which are collectively representative of the area in which guidelines will be applied.
- **Partitioning** - geometric mean of at least three log K_{ow} values (with 95% confidence limits) used to estimate log K_{oc}. Measured K_{ow} values are preferred. Values calculated from fragment analysis or aqueous solubility may be included if necessary to obtain the three values.
- **AET** - at least 20 toxicity tests on the same sensitive species with comparable endpoints and controls, and with contaminant concentrations measured in sediments. The highest concentration must be effective to permit AET calculation.
- **SLC** - at least ten benthic species, and ten samples of each from the area in which guidelines will be applied, with chemical contaminants and TOC measured in the sediments.
- **Spiked Bioassay** - spiked bioassay data showing a significant dose-response for a non-tolerant benthic organism using a single contaminant measured in bulk sediments.

TABLE 5.1: FINAL SELECTION OF PROPOSED SEDIMENT QUALITY GUIDELINES COMPARED TO EXISTING REGULATORY GUIDELINES

Contaminant	Proposed Guideline (ug/g)	Method of Derivation[1]	Existing Guideline (ug/g) MOE[2]	 U.S. EPA Region V[3]	 WDNR[4]
Arsenic	17	SLC*	8	3	10
Cadmium	2.5	Background	1	-	1
Chromium	100	Bioassay	25	25	100
Copper	85	Bioassay	25	25	100
Iron (%)	5.9	Background	1	1.7	-
Lead	55	Background	50	40	50
Manganese (%)	0.12	Background	-	0.03	-
Mercury	0.6	Background	0.3	1	0.1
Nickel	92	SLC	25	20	100
Zinc	143	Background	100	90	100
Heptachlor	0.008	SLC	-	-	0.05
Endrin	0.012	SLC	-	-	0.05
Mirex	0.028	SLC	-	-	-
Aldrin	0.008	SLC	-	-	0.01
Chlordane	0.03	SLC	-	-	0.01
DDT (total)	0.02	Partitioning	-	-	-
p,p-DDT	0.036	SLC	-	-	-
p,p-DDD	0.032	SLC	-	-	-
p,p-DDE	0.02	SLC	-	-	-
p,p-DDT	0.024	SLC	-	-	-
PCBs	0.16	SLC*	0.05	10	0.05
PCB 1254	0.23	SLC	-	-	-
PCB 1248	0.14	SLC	-	-	-
PCB 1016	0.03	SLC	-	-	-
Dieldrin	0.076	SLC	-	-	0.01
BHC	0.013	SLC	-	-	-
γ-BHC	0.012	SLC	-	-	0.05
β-BHC	0.02	SLC	-	-	-
α-BHC	0.024	SLC	-	-	-
HCB	0.08	SLC	-	-	-
Heptachlor Epoxide	0.018	SLC	-	-	-
γ-chlordane	0.002	SLC	-	-	-

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[1] Proposed guidelines based on SLC and partitioning were derived in ug/g C and adjusted to bulk sediment basis assuming an average 4% total organic carbon. * indicates SLC derivation from the MOE In-Place Pollutants database.

[2] Open water dredge spoil disposal guidelines (Persaud and Wilkins, 1976).

[3] Guidelines for the pollutional classification of Great Lakes harbour sediments (U.S. EPA, 1977).

[4] Wisconsin Department of Natural Resources interim criteria and guidance criteria for in-water disposal of dredge material (Sullivan et al., 1985).

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APPENDIX A

Sediment Background and Benchmark Data

APPENDIX TABLE A-1: BACKGROUND ARSENIC CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Erie	-	-	-	0.2-1.0	Mudroch et al. (1988)
	Lake Erie	1972	3	14-260	0.59 (0.17-0.79)	Walters et al. (1974)
	Lake Michigan	-	-	-	5-8	Mudroch et al. (1988)
	Lake Michigan	1970	11	GT 20	5.0 (2.9-7.5)	Ruch et al. (1970)
Embayment/River Mouths/Harbours	Lake Erie	-	-	-	0.5-1.2	Mudroch et al. (1988)
	Thunder Bay	1988	15	10-128	4.1 (1-15)	BEAK (1988)
	Lake Michigan	-	-	-	8-15	Mudroch et al. (1988)

APPENDIX TABLE A-2: BACKGROUND CADMIUM CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Ontario	1971	5	15-40	1.3 (0.9-2.0)	Kemp and Dell (1976)
	Lake Ontario	1984	-	9-10	2.3-3.7	Mudroch et al. (1988
	Lake Erie	1971	6	15-50	1.1 (0.5-1.7)	Kemp and Dell (1976)
	Lake Erie	1972	3	14-260	0.7 (L 0.1-1.6)	Walters et al. (1974)
	Lake Erie	1973	-	GT 10	3.1±0.4	Plumb and Sweeney (1980
	Lake Erie	1973	-	GT 10	1.5±0.4	Plumb and Sweeney (1980
	Lake Erie	1973	-	GT 10	3.2±0.9	Plumb and Sweeney (1980
	Lake Erie	1976	-	30-120	0.9	Mudroch et al. (1988)
	Lake Erie	1976	21	pre-colonial	1.0	Nriagu et al. (1979)
	Lake Huron	1971	2	8.0-30.0	1.4 (1.0-1.8)	Kemp and Thomas (1976)
	Lake Huron	1974-75	20	20-50	1.6 (0.7-3.8)*	Robbins (1980)
	Lake Huron	1978	-	12-30	0.2-0.9	Mudroch et al. (1988)
	Lake Michigan	1981	-	10	0.5-0.7	Mudroch et al. (1988)
	Lake Superior	1978	-	10-20	0.4-0.7	Mudroch et al. (1988)
Non-depositional Zone	Georgian Bay	1978	-	10-24	0.6-1.0	Mudroch et al. (1988)
Embayments/River Mouths/Harbours	Hamilton Harbour	1976	17	-	1.1±1.9	MOE (1978)
	Buffalo Harbor	1974	-	18	0.1	Mudroch et al. (1988)
	South Bay	1971	1	8-10	1.5	Kemp and Thomas (1976)
	South Bay	1978	-	20-30	1.0	Mudroch et al. (1988)
	Green Bay	1981	-	15	0.5-1.3	Mudroch et al. (1988)
	Pic River	1972	1	GT 10	1.2 (1.1-1.3)	Fitchko (1974)
	Nipigon River	1972	1	GT 10	0.9 (0.7-1.0)	Fitchko (1974)
	McIntyre River	1972	1	GT 10	0.7 (0.6-0.8)	Fitchko (1974)
	Kaministikwia River	1972	1	GT 10	1.0 (0.9-1.1)	Fitchko (1974)
	Lower Keweenaw Entry	1972	1	GT 10	0.3 (0.2-0.3)	Fitchko (1974)
	Betsie Lake Outlet	1972	1	GT 10	0.5 (0.4-0.6)	Fitchko (1974)
	Trail River	1972	1	GT 10	0.8 (0.5-1.1)	Fitchko (1974)
	French River	1972	2	GT 15	1.0 (0.9-1.1)	Fitchko (1974)
	Magnetawan River	1972	1	GT 10	0.6	Fitchko (1974)
	Moon River	1972	2	GT 10	1.2 (0.9-1.3)	Fitchko (1974)
	Musquash River	1972	2	GT 10	0.9 (0.6-1.0)	Fitchko (1974)
	Severn River	1972	1	GT 10	1.0 (0.8-1.1)	Fitchko (1974)
	Napanee River	1972	2	GT 30	1.1 (1.0-1.1)	Fitchko (1974)
	Conneaut River	1973	1	GT 10	0.8 (0.7-0.9)	Fitchko (1974)
	Thunder Bay	1988	15	10-128	0.2 (0.1-1.1)	BEAK (1988)
	Hamilton/Toronto Harbour	1975?	3	70-100	1.0	Nriagu et al. (1983)

* Mean of means (range of means)

L - less than

GT - greater than

APPENDIX TABLE A-3: BACKGROUND CHROMIUM CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Ontario	1983	-	9-10	63-86	Mudroch et al. (1988)
	Lake Erie	1972	3	14-260	18 (10-30)	Walters et al. (1974)
	Lake Erie	1973	-	GT 10	73±4	Plumb and Sweeney (1980
	Lake Erie	1973	-	GT 10	39±2	Plumb and Sweeney (1980
	Lake Erie	1973	-	GT 10	45±2	Plumb and Sweeney (1980
	Lake Erie	1973	18	-	18 (9-32)*	Walters and Wolery (1974)
	Lake Huron	1974-75	25	20-50	53 (24-83)*	Robbins (1980)
	Lake Huron	1978	-	10-28	30-47	Mudroch et al. (1988)
	Lake Michigan	1970	10	GT 20	53 (32-68)	Shimp et al. (1971)
	Lake Michigan	1981	-	-	50	Mudroch et al. (1988)
	Lake Superior	1978	-	-	26-73	Mudroch et al. (1988)
Non-depositional Zone	Lake Ontario	1983	-	10-GT 25	45-100	Mudroch et al. (1988)
	Saginaw Bay	1975	10	GT 20	42 (10-93)	Robbins (1981)
	Georgian Bay	1978	-	10-24	29-44	Mudroch et al. (1988)
	Lake Superior	1978	-	-	50-52	Mudroch et al. (1988)
	Lake Superior	1971	2	GT 20	53 (20-88)	Mothersill and Fung (1972
Embayments/River Mouths/Harbours	Hamilton Harbour	1976	17	-	34±45	MOE (1978)
	Buffalo Harbor	1972	1	GT 25	30	Walters et al. (1974)
	Cleveland Harbor	1972	1	95	30	Walters et al. (1974)
	Nipigon River	1972	1	GT 10	16 (13-19)	Fitchko (1974)
	Pic River	1972	1	GT 10	12 (11-13)	Fitchko (1974)
	McIntyre River	1972	1	GT 10	8 (7-10)	Fitchko (1974)
	Kaministikwia River	1972	1	GT 10	11 (9-12)	Fitchko (1974)
	Lower Keweenaw Entry	1972	1	GT 10	1 (L 1-2)	Fitchko (1974)
	Betsie Lake Outlet	1972	1	GT 10	1	Fitchko (1974)
	Trail River	1972	1	GT 10	2 (1-3)	Fitchko (1974)
	French River	1972	2	GT 15	15 (12-17)	Fitchko (1974)
	Magnetawan River	1972	1	GT 10	4 (3-5)	Fitchko (1974)
	Moon River	1972	2	GT 10	8 (6-10)	Fitchko (1974)
	Musquash River	1972	2	GT 10	6 (3-8)	Fitchko (1974)
	Severn River	1972	1	GT 10	9 (7-11)	Fitchko (1974)
	Napanee River	1972	2	GT 30	25 (21-31)	Fitchko (1974)
	Conneaut River	1973	1	GT 10	18 (13-28)	Fitchko (1974)
	Thunder Bay	1988	15	10-128	67 (44-104)	BEAK (1988)
	Buffalo Harbor	1973	1	-	19	Walters and Wolery (1974)
	Hamilton/Toronto Harbours	1975?	3	70-100	55	Nriagu et al. (1983)

* Means of means (range of means)

L - less than

GT - greater than

APPENDIX TABLE A-4: BACKGROUND COPPER CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Ontario	1971	5	15-40	44 (35-56)	Kemp and Dell (1976
	Lake Ontario	1983	-	9-10	43-50	Mudroch et al. (1988)
	Lake Erie	1971	6	15-120	29 (20-34)	Kemp and Dell (1976)
	Lake Erie	1972	3	14-260	12 (7.1-21)	Walters et al. (1974)
	Lake Erie	1973	2	24-260	14 (6.3-38)	Walters and Wolery (1974)
	Lake Erie	1979	17	pre-colonial	48	Nriagu et al. (1979)
	Lake Huron	1971	2	8-30	40 (40-41)	Kemp and Thomas (1976)
	Lake Huron	1974-75	27	20-50	30 (8-44)*	Robbins (1980)
	Lake Huron	1978	-	10-30	31-48	Mudroch et al. (1988)
	Lake Michigan	1970	10	GT 20	19 (8-32)	Shimp et al. (1971)
	Lake Michigan	1981	-	-	15	Mudroch et al. (1988)
	Lake Superior	1978	-	-	30-84	Mudroch et al. (1988)
Non-depositional Zone	Lake Ontario	1983	-	10-GT 25	60-100	Mudroch et al. (1988)
	Saginaw Bay	1975	13	GT 20	10 (3-31)	Robbins (1981)
	Georgian Bay	1978	-	10-24	43-51	Mudroch et al. (1988)
	Lake Superior	1971	2	GT 20	64 (60-71)	Mothersill and Fung (1972)
	Lake Superior	1978	-	14-20	57-69	Mudroch et al. (1988)
Embayments/River Mouths/Harbours	Buffalo Harbor	1972	1	25	10	Walters et al. (1974)
	Cleveland Harbor	1972	1	120	10	Walters et al. (1974)
	South Bay	1971	1	8-10	33	Kemp and Thomas (1976)
	South Bay	1978	-	30-40	25	Mudroch et al. (1988)
	Pic River	1972	1	GT 10	12 (8-16)	Fitchko (1974)
	Nipigon River	1972	1	GT 10	22 (21-22)	Fitchko (1974)
	McIntyre River	1972	1	GT 10	13 (8-16)	Fitchko (1974)
	Kaministikwia River	1972	1	GT 10	21 (19-23)	Fitchko (1974)
	Lower Keweenaw Entry	1972	1	GT 10	15 (7-22)	Fitchko (1974)
	Betsie Lake Outlet	1972	1	GT 10	3 (1-4)	Fitchko (1974)
	Trail River	1972	1	GT 10	7 (3-10)	Fitchko (1974)
	French River	1972	2	GT 15	11 (10-12)	Fitchko (1974)
	Magnetawan River	1972	1	GT 10	8 (6-9)	Fitchko (1974)
	Moon River	1972	2	GT 10	13 (12-14)	Fitchko (1974)
	Musquash River	1972	2	GT 10	9 (4-14)	Fitchko (1974)
	Severn River	1972	1	GT 10	9 (7-10)	Fitchko (1974)
	Napanee River	1972	2	GT 30	12 (10-13)	Fitchko (1974)
	Conneaut River	1973	1	GT 10	20 (13-28)	Fitchko (1974)
	French River	1975	2	GT 10	10 (8-12)	Fitchko (1978)
	Thunder Bay	1988	15	10-128	54 (41-80)	BEAK (1988)
	Cleveland Harbor	1973	1	121-125	15	Walters and Wolery (1974)
	Buffalo Harbor	1973	1	23-55	16 (14-18)	Walters and Wolery (1974)
	Hamilton/Toronto Harbours	1975?	3	70-100	26	Nriagu et al. (1983)
	Bay of Quinte	1977?	1	GT 22	19	Mudroch and Capobianco (1980)

* Mean of means (range of means)

GT - greater than

APPENDIX TABLE A-5: BACKGROUND IRON CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Ontario	1971	5	15-40	4.55 (3.74-5.25)	Kemp and Dell (1976)
	Lake Ontario	1983	-	9-10	1.92	Mudroch et al. (1988)
	Lake Erie	1971	6	15-50	3.82 (2.76-3.89)	Kemp and Dell (1976)
	Lake Erie	1972	3	14-260	1.7 (0.89-2.9)	Walters et al. (1974)
	Lake Erie	1973	-	GT 10	3.84±0.42	Plumb and Sweeney (1980)
	Lake Erie	1973	-	GT 10	3.13±0.12	Plumb and Sweeney (1980)
	Lake Erie	1973	-	GT 10	3.40±0.24	Plumb and Sweeney (1980)
	Lake Erie	1973	2	24-260	1.29 (0.78-1.90)	Walters and Wolery (1974)
	Lake Erie	1976	-	30-120	4.67-4.82	Mudroch et al. (1988)
	Lake Huron	1971	2	8-30	4.44 (4.24-4.65)	Kemp and Thomas (1976)
	Lake Huron	1974-75	27	20-50	2.59 (0.98-4.00)*	Robbins (1980)
	Lake Huron	1978	-	10-30	3.22-5.02	Mudroch et al. (1988)
	Lake Huron	1980	-	-	1.15-4.30	Mudroch et al. (1988)
	Lake Superior	1978	-	10-20	3.18-5.88	Mudroch et al. (1988)
Non-depositional Zone	Saginaw Bay	1975	10	GT 20	1.77 (0.80-3.17)	Robbins (1981)
	Georgian Bay	1978	-	10-24	5.04-5.20	Mudroch et al. (1988)
	Lake Superior	1971	2	GT 20	4.09 (3.98-4.24)	Mothersill and Fung (1972)
	Lake Superior	1978	-	14-20	5.37-5.94	Mudroch et al. (1988)
Embayments/River Mouths/Harbours	Hamilton Harbour	1976	17	-	2.0±0.8	MOE (1978)
	Buffalo Harbor	1974	-	25	1.1	Mudroch et al. (1988)
	Cleveland Harbor	1974	-	120	1.5	Mudroch et al. (1988)
	South Bay	1971	1	8-10	4.07	Kemp and Thomas (1976)
	South Bay	1978	-	20-30	4.36	Mudroch et al. (1988)
	Cleveland Harbor	1973	1	121-125	1.8	Walters and Wolery (1974)
	Buffalo Harbor	1973	1	23-55	1.3 (1.2-1.4)	Walters and Wolery (1974)
	Hamilton/Toronto Harbours	1975?	3	70-100	3.1	Nriagu et al. (1983)

* Mean of means (range of means)

GT - greater than

APPENDIX TABLE A-6: BACKGROUND LEAD CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Ontario	1971	5	15-40	30 (26-32)	Kemp and Dell (1976)
	Lake Ontario	1983	-	9-10	18-19	Mudroch et al. (1988)
	Lake Erie	1971	6	15-120	28 (21-49)	Kemp and Dell (1976)
	Lake Erie	1979	17	pre-colonial	26	Nriagu et al. (1979)
	Lake Huron	1971	2	8-30	30 (24-36)	Kemp and Thomas (1976)
	Lake Huron	1974-75	27	20-50	27 (13-51)*	Robbins (1980)
	Lake Huron	1978	-	10-30	14-29	Mudroch et al. (1988)
	Lake Michigan	1970	10	GT 20	20 (16-31)	Shimp et al. (1971)
	Lake Michigan	1981	-	10	8-10	Mudroch et al. (1988)
	Lake Michigan	1981	-	-	10	Mudroch et al. (1988)
	Lake Superior	1978	-	10-20	21-68	Mudroch et al. (1988)
Non-depositional Zone	Lake Ontario	1983	-	14-GT 25	25	Mudroch et al. (1988)
	Saginaw Bay	1975	13	GT 20	23 (10-51)	Robbins (1981)
	Georgian Bay	1978	-	10-24	43-51	Mudroch et al. (1988)
	Lake Superior	1978	-	14-20	18-25	Mudroch et al. (1988)
Embayments/River Mouths/Harbours	Hamilton Harbour	1976	17	-	28±34	MOE (1978)
	South Bay	1971	1	8-10	58	Kemp and Thomas (1976)
	South Bay	1978	-	10-24	87-93	Mudroch et al. (1988)
	South Bay	1978	-	20-30	34	Mudroch et al. (1988)
	Green Bay	1981	-	15	8-29	Mudroch et al. (1988)
	Pic River	1972	1	GT 10	12 (11-13)	Fitchko (1974)
	Nipigon River	1972	1	GT 10	17 (13-21)	Fitchko (1974)
	McIntyre River	1972	1	GT 10	10 (8-12)	Fitchko (1974)
	Kaministikwia River	1972	1	GT 10	8 (7-8)	Fitchko (1974)
	Lower Keneenaw Entry	1972	1	GT 10	5 (4-6)	Fitchko (1974)
	Betsie Lake Outlet	1972	1	GT 10	8 (4-11)	Fitchko (1974)
	Trail River	1972	1	GT 10	16 (7-25)	Fitchko (1974)
	French River	1972	2	GT 15	21 (12-26)	Fitchko (1974)
	Magnetawan River	1972	1	GT 10	7 (6-8)	Fitchko (1974)
	Moon River	1972	2	GT 10	10 (8-14)	Fitchko (1974)
	Musquash River	1972	2	GT 10	8 (6-9)	Fitchko (1974)
	Severn River	1972	1	GT 10	12 (8-18)	Fitchko (1974)
	Napanee River	1972	2	GT 30	12 (8-16)	Fitchko (1974)
	Conneaut River	1973	1	GT 10	13 (11-17)	Fitchko (1974)
	Thunder Bay	1988	15	10-128	13 (8-20)	BEAK (1988)
	Hamilton/Toronto Harbours	1975?	3	70-100	27	Nriagu et al. (1983)

* Mean of means (range of means)

GT - greater than

APPENDIX TABLE A-7: BACKGROUND MANGANESE CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Ontario	1971	5	15-40	0.15 (0.06-0.23)	Kemp and Dell (1976)
	Lake Erie	1971	6	5-120	0.07 (0.06-0.10)	Kemp and Dell (1976)
	Lake Huron	1971	2	8-30	0.09 (0.09-0.10)	Kemp and Thomas (1976)
	Lake Huron	1974-75	27	20-50	0.036 (0.017-0.066)*	Robbins (1980)
Non-depositional Zone	Saginaw Bay	1975	10	GT 20	0.042 (0.013-0.066)	Robbins (1981)
	Lake Superior	1971	2	GT 20	0.090 (0.079-0.106)	Mothersill and Fung (1972)
Embayments/River Mouths/Harbours	South Bay	1971	1	8-10	0.10	Kemp and Thomas (1976)
	Pic River	1972	1	GT 10	0.011 (0.010-0.013)	Fitchko (1974)
	Nipigon River	1972	1	GT 10	0.011 (0.010-0.012)	Fitchko (1974)
	McIntyre River	1972	1	GT 10	0.014 (0.012-0.016)	Fitchko (1974)
	Kaministikwia River	1972	1	GT 10	0.013 (0.012-0.014)	Fitchko (1974)
	Lower Keweenaw Entry	1972	1	GT 10	0.004 (0.003-0.005)	Fitchko (1974)
	Betsie Lake Outlet	1972	1	GT 10	0.005 (0.002-0.007)	Fitchko (1974)
	Trail River	1972	1	GT 10	0.006 (0.003-0.008)	Fitchko (1974)
	French River	1972	2	GT 15	0.020 (0.018-0.022)	Fitchko (1974)
	Magnetawan River	1972	1	GT 10	0.014 (0.012-0.016)	Fitchko (1974)
	Moon River	1972	2	GT 10	0.046 (0.043-0.050)	Fitchko (1974)
	Musquash River	1972	2	GT 10	0.011 (0.009-0.014)	Fitchko (1974)
	Severn River	1972	1	GT 10	0.017 (0.012-0.020)	Fitchko (1974)
	Napanee River	1972	2	GT 30	0.039 (0.034-0.043)	Fitchko (1974)
	Conneaut River	1973	1	GT 10	0.020 (0.014-0.024)	Fitchko (1974)
	Hamilton/Toronto Harbours	1975?	3	70-100	0.061	Nriagu et al. (1983)

* Mean of means (range of means)

GT - greater than

APPENDIX TABLE A-8: BACKGROUND MERCURY CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Ontario	1971	5	15-40	0.07 (0.03-0.09)	Kemp and Dell (1976)
	Lake Erie	1971	6	15-50	0.08 (0.04-0.19)	Kemp and Dell (1976)
	Lake Erie	1972	-	5-14	0.65-0.73	Mudroch et al. (1988)
	Lake Erie	1972	3	14-260	0.04 (0.02-0.06)	Walters et al. (1974)
	Lake Erie	1973	-	GT 10	0.10±0.03	Plumb and Sweeney (1980)
	Lake Erie	1973	-	GT 20	0.04-0.09	Mudroch et al. (1988)
	Lake Erie	1973	-	GT 10	0.27±0.11	Plumb and Sweeney (1980)
	Lake Erie	1973	-	GT 10	0.31±0.08	Plumb and Sweeney (1980)
	Lake Erie	1973	18	-	0.04 (0.02-0.07)	Walters and Wolery (1974)
	Lake Erie	1976	-	30-120	0.04-0.09	Mudroch et al. (1988)
	Lake Huron	1971	2	8-30	0.07 (0.07-0.08)	Kemp and Thomas (1976)
	Lake Huron	1978	-	10-30	0.04-0.08	Mudroch et al. (1988)
	Lake Michigan	1971		GT 20	0.08 (0.03-0.77)	Kennedy et al. (1971)
	Lake Superior	1978		10-20	0.04-0.07	Mudroch et al. (1988)
Non-depositional Zone	Lake Ontario	1983		25	0.40-0.70	Mudroch et al. (1988)
	Georgian Bay	1978		10-24	0.03-0.05	Mudroch et al. (1988)
	Lake Superior	1978		14-20	0.08	Mudroch et al. (1988)
Embayments/River Mouths/Harbours	Buffalo Harbor	1972		25	0.05	Walters et al. (1974)
	Cleveland Harbor	1972		120	0.20	Walters et al. (1974)
	South Bay	1971		8-10	0.30	Kemp and Thomas (1976)
	South Bay	1978		20-30	0.32	Mudroch et al. (1988)
	Thunder Bay	1988		10-128	0.06 (L 0.02-0.58)	BEAK (1988)
	Buffalo Harbor	1973		-	0.04	Walters and Wolery (1974)
	Hamilton Harbour	1976	17	-	0.05±0.10	MOE (1978)

L - less than

GT - greater than

APPENDIX TABLE A-9: BACKGROUND NICKEL CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Ontario	1983	-	9-10	42-48	Mudroch et al. (1988)
	Lake Erie	1972	3	14-260	40 (10-76)	Walters et al. (1974)
	Lake Erie	1973	17	-	41 (24-80)	Walters and Wolery (1974)
	Lake Huron	1974-75	27	20-50	35 (17-52)*	Robbins (1980)
	Lake Huron	1978	-	10-28	30-51	Mudroch et al. (1988)
	Lake Michigan	1970	10	GT 20	34 (26-42)	Shimp et al. (1971)
	Lake Michigan	1981	-	-	20	Mudroch et al. (1988)
	Lake Superior	1978	-	10-20	24-70	Mudroch et al. (1988)
Non-depositional Zone	Lake Ontario	1983	-	11-GT 25	30-100	Mudroch et al. (1988)
	Saginaw Bay	1975	12	GT 20	22 (0-49)	Robbins (1981)
	Georgian Bay	1978	-	10-24	50-61	Mudroch et al. (1988)
	Lake Superior	1971	2	GT 20	89 (80-108)	Mothersill and Fung (1972)
	Lake Superior	1978	-	14-20	58-64	Mudroch et al. (1988)
Embayments/River Mouths/Harbours	Buffalo Harbor	1973	1	-	57	Walters and Wolery (1974)
	Hamilton Harbour	1976	17	-	14±7	MOE (1978)
	Buffalo Harbor	1974	-	40	65	Mudroch et al. (1988)
	Cleveland Harbor	1974	-	90	55	Mudroch et al. (1988)
	Pic River	1972	1	GT 10	15 (14-15)	Fitchko (1974)
	Nipigon River	1972	1	GT 10	21 (20-21)	Fitchko (1974)
	McIntyre River	1972	1	GT 10	17 (15-19)	Fitchko (1974)
	Kaministikwia River	1972	1	GT 10	24 (22-26)	Fitchko (1974)
	Lower Keweenaw Entry	1972	1	GT 10	7 (6-8)	Fitchko (1974)
	Betsie Lake Outlet	1972	1	GT 10	6 (4-8)	Fitchko (1974)
	Trail River	1972	1	GT 10	9 (5-12)	Fitchko (1974)
	French River	1972	2	GT 15	22 (19-24)	Fitchko (1974)
	Magnetawan River	1972	1	GT 10	12 (10-13)	Fitchko (1974)
	Moon River	1972	2	GT 10	19 (15-22)	Fitchko (1974)
	Musquash River	1972	2	GT 10	14 (9-19)	Fitchko (1974)
	Severn River	1972	1	GT 10	13 (10-16)	Fitchko (1974)
	Napanee River	1972	2	GT 30	15 (14-17)	Fitchko (1974)
	Conneaut River	1973	1	GT 10	11 (9-14)	Fitchko (1974)
	French River	1975	2	GT 10	23 (16-35)	Fitchko (1978)
	Hamilton/Toronto Harbours	1975?	3	70-100	44	Nriagu et al. (1983)
	Bay of Quinte	1977?	1	GT 22	17	Mudroch and Capobianco (198

* Mean of means (range of means)

GT - greater than

APPENDIX TABLE A-10: BACKGROUND ZINC CONCENTRATIONS

Sample Location Type	Location	Year	No. of Cores	Core Sample Depth (cm)	Mean (Range) Concentration (ug/g)	Reference
Depositional Basin	Lake Ontario	1971	5	15-40	105 (86-121)	Kemp and Dell (1976)
	Lake Ontario	1983	-	9-10	83-163	Mudroch et al. (1988)
	Lake Erie	1971	6	5-120	98 (69-128)	Kemp and Dell (1976)
	Lake Erie	1972	3	14-260	18 (5-37)	Walters et al. (1974)
	Lake Erie	1973	2	24-260	38 (4.5-68)	Walters and Wolery (1974
	Lake Erie	1979	17	pre-colonial	90	Nriagu et al. (1979)
	Lake Huron	1971	2	8-30	88	Kemp and Thomas (1976)
	Lake Huron	1974-75	27	20-50	63 (34-86)*	Robbins (1980)
	Lake Huron	1978	-	10-30	60-88	Mudroch et al. (1988)
	Lake Michigan	1970	10	GT 20	64 (22-80)	Shimp et al. (1971)
	Lake Michigan	1981	-	10	40-45	Mudroch et al. (1988)
	Lake Michigan	1981	-	-	50	Mudroch et al. (1988)
	Lake Superior	1978	-	10-20	53-137	Mudroch et al. (1988)
Non-depositional Zone	Lake Ontario	1983	-	13-45	100	Mudroch et al. (1988) .
	Saginaw Bay	1975	13	GT 20	48 (0-130)	Robbins (1981)
	Georgian Bay	1978	-	10-24	87-93	Mudroch et al. (1988)
	Lake Superior	1971	2	GT 20	104 (79-129)	Mothersill and Fung (197
	Lake Superior	1978	-	19-20	105-117	Mudroch et al. (1988)
Embayments/River Mouths/Harbours	Hamilton Harbour	1976	17	-	210±260	MOE (1978)
	Buffalo Harbor	1972	1	25	50	Walters et al. (1974)
	Cleveland Harbor	1972	1	120	40	Walters et al. (1974)
	South Bay	1971	1	8-10	116	Kemp and Thomas (1976)
	South Bay	1978	-	20-30	78	Mudroch et al. (1988)
	Green Bay	1981	-	15	50-80	Mudroch et al. (1988)
	Pic River	1972	1	GT 10	27 (20-38)	Fitchko (1974)
	Nipigon River	1972	1	GT 10	21 (20-22)	Fitchko (1974)
	McIntyre River	1972	1	GT 10	35 (27-44)	Fitchko (1974)
	Kaministikwia River	1972	1	GT 10	41 (37-44)	Fitchko (1974)
	Lower Keweenaw Entry	1972	1	GT 10	9 (7-10)	Fitchko (1974)
	Betsie Lake Outlet	1972	1	GT 10	5 (1-9)	Fitchko (1974)
	Trail River	1972	1	GT 10	32 (17-46)	Fitchko (1974)
	French River	1972	2	GT 15	63 (50-75)	Fitchko (1974)
	Magnetawan River	1972	1	GT 10	25 (16-34)	Fitchko (1974)
	Moon River	1972	2	GT 10	74 (63-87)	Fitchko (1974)
	Musquash River	1972	2	GT 10	89 (54-109)	Fitchko (1974)
	Severn River	1972	1	GT 10	54 (30-74)	Fitchko (1974)
	Napanee River	1972	2	GT 30	80 (76-84)	Fitchko (1974)
	Conneaut River	1973	1	GT 10	61 (55-69)	Fitchko (1974)
	French River	1975	2	GT 10	47 (40-64)	Fitchko (1978)
	Buffalo Harbor	1973	1	48-55	13	Walters and Wolery (1974
	Hamilton/Toronto Harbours	1975?	3	70-100	34	Nriagu et al. (1983)

* Mean of means (range of means)

GT - greater than

APPENDIX TABLE A-11: METAL CONCENTRATIONS IN BLUFFS MATERIALS

	Mean ± S.D.[1] Concentration (ug/g unless otherwise indicated)						
	Lake Ontario			Lake Erie			Lake Superior
Parameter	No Date[2]	1972-1973[3]	1985[4]	No Date[2]	1972-1973[3]	1985[4]	1974[5]
Arsenic	-	2.6±1.7	2.8±2.7	-	6.1±4.3	5.4±3.1	9.9[6] (8.8-10.5)[7]
Cadmium	1.5 (0.2-3.2)	1.5±0.5	0.7±0.4	1.8 (0.7-2.8)	1.3±0.5	0.4±0.2	-
Chromium	-	18±17	31±14	-	38±44	35±11	88 (84-90)
Copper	25 (8-44)	19±16	26±11	26 (15-89)	15±9	26±10	30±2
Iron (%)	2.62 (1.29-3.52)	-	1.81±0.70	2.65 (1.71-3.09)	-	1.77±0.60	4.54 (4.00-4.82)
Lead	27 (12-35)	18±13	12±8	39 (33-47)	17±6	10±4	-
Manganese (%)	0.06 (0.04-0.09)	-	0.04±0.02	0.06 (0.04-0.06)	-	0.04±0.02	-
Mercury	0.05 (0.01-0.08)	0.02±0.02	0.02±0.02	0.04 (0.04-0.05)	0.02±0.01	0.01±0.00	0.02±0.01
Nickel	-	17±9	15±7	-	18±11	17±8	-
Zinc	41 (16-65)	42±65	40±21	54 (39-76)	46±29	49±13	110 (104-116)

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[1] S.D. = standard deviation.

[2] Kemp and Dell (1976); collection date not provided.

[3] 1972-1973 PLUARG data provided by Boyd (1988).

[4] 1985 MOE data provided by Boyd (1988).

[5] Helmke et al. (1976)

[6] Mean of means.

[7] (range of means).

APPENDIX TABLE A-12: ORGANOCHLORINE CONCENTRATIONS IN SEDIMENT CORES COLLECTED FROM THE GREAT LAKE

Location	Core No.	Core Depth (cm)	Approximate Dating	Concentration (ug/g)				
				p,p-DDE	p,p-DDD	p,p-DDT	PCB	Chlordane
Lake Ontario[1]	E-30	0-1	1970-1976	0.057	0.075	0.017	-	0.005
		1-2	1964-1970	0.028	0.039	0.007	-	0.002
		2-3	1958-1964	0.009	0.012	ND	-	ND
		3-22	pre-1958	ND[2]	ND	ND	-	ND
	G-33	0-1	1968-1976	0.042	0.066	0.015	-	0.002
		1-2	1960-1968	0.010	0.013	0.002	-	ND
		2-22	pre-1960	ND	ND	ND	-	ND
Lake Erie[3]	-	0-2	1969-1971	0.019	0.053	ND	0.340	-
		2-4	1966-1968	0.009	0.020	ND	0.010	-
		4-6	1963-1965	0.002	0.002	ND	0.006	-
		6-8	1961-1963	0.003	0.001	ND	0.010	-
		8-10	1958-1960	0.002	ND	ND	ND	-
		10-12	1956-1958	ND	ND	ND	0.001	-
		12-14	1953-1955	ND	ND	ND	ND	-
		14-112	1827-1952	ND	ND	ND	ND	-
Lake Huron[4]	D.H.	0-2	1943-1971	0.008	0.005	0.009	0.100	-
		2-4	1915-1942	ND	ND	ND	ND	-
		4-10	1829-1914	ND	ND	ND	ND	-
	U9	0-2	1960-1971	0.003	0.002	0.003	0.030	-
		2-4	1948-1959	0.004	ND	ND	0.010	-
		4-6	1936-1947	ND	ND	ND	0.010	-
		6-10	1894-1935	ND	ND	ND	ND	-
Georgian Bay[4]	C7A	0-1	1924-1974	0.014	0.006	0.008	0.020	-
		1-10	1424-1924	ND	ND	ND	ND	-
	C12A	0-1	1924-1974	0.008	0.002	0.007	0.009	-
		1-3	1824-1923	ND	ND	ND	ND	-
	J3A	0-1	1950-1974	0.014	0.005	0.010	0.005	-
		1-2	1925-1949	0.005	0.005	0.002	0.005	-
		2-10	1725-1925	ND	ND	ND	ND	-
South Bay[4]	SB	0-3	1920-1970	0.018	0.009	0.009	0.020	-
		3-10	1808-1920	ND	ND	ND	ND	-

[1] Based on Frank _et al._ (1979a).

[2] ND = not detected.

[3] Based on Frank _et al._ (1977).

[4] Based on Frank _et al._ (1979b).

APPENDIX TABLE A-13: ORGANOCHLORINE CONCENTRATIONS IN BLUFFS MATERIALS[1]

	Concentration Range (ug/g)	
Parameter	Lake Ontario[2]	Lake Erie[2]
Aldrin	ND[3]	ND
α-Chlordane	ND	ND
γ-Chlordane	ND	ND
Oxy-chlordane	ND	ND
o,p-DDT	ND	ND
p,p-DDD	ND	ND
p,p-DDE	ND - 0.096 (6)[4]	ND - 0.002 (2)
p,p-DDT	ND - 0.020 (1)	ND
Dieldrin	ND - 0.002 (1)	ND - 0.002 (1)
α-BHC	ND - 0.001 (1)	ND
β-BHC	ND - 0.001 (1)	ND
γ-BHC	ND - 0.001 (1)	ND
Heptachlor	ND	ND
Heptachlor Epoxide	ND - 0.001 (1)	ND
Mirex	ND	ND
Hexachlorobenzene	ND	ND
PCBs	ND - 0.040 (1)	ND
Endrin	ND	ND

[1] 1985 MOE data provided by MOE (1988).

[2] Based on 18 samples collected.

[3] ND = not detected.

[4] (number of samples above the detection limit).

APPENDIX TABLE A-14: ORGANOCHLORINE CONCENTRATIONS IN GREAT LAKES BASIN SURFICIAL SEDIMENTS

Location	No. of Samples	Mean Concentration (ug/g)						Reference
		p,p-DDE	p,p-DDD	o,p-DDT	p,p-DDT	DDT	Dieldrin	
Lake Erie Basin								
Ontario Tobacco Belt	158	0.031	0.031	0.006	0.027	0.095	0.001	Frank et al. (1974)
Long Point Bay	21	0.005	0.021	L 0.001	0.003	0.029	L 0.001	Frank et al. (1974)
Lake Erie Proper	259	0.008	0.018	-	0.001	0.028	-	Frank et al. (1977)
Lake Ontario Basin								
Bay of Quinte Tributaries	32	0.014	0.048	ND[1]	0.009	0.070	L 0.001	Frank et al. (1974)
Bay of Quinte	47	0.010	0.013	ND	0.002	0.026	L 0.001	Frank et al. (1974)
Lake Ontario Proper	229	0.013	0.013	0.002	0.016	0.043	-	Frank et al. (1979a)
Georgian Bay Basin								
Muskoka Lake/River System	44	0.068	0.073	ND	0.016	0.157	ND	Frank et al. (1974)
North Channel	55	0.002	L 0.001	L 0.001	0.001	0.004	-	Frank et al. (1979b)
Georgian Bay	115	0.003	0.002	L 0.001	0.002	0.006	-	Frank et al. (1979b)

[1] ND - not detected.

L - less than.

APPENDIX TABLE A-15: ORGANOCHLORINE CONCENTRATIONS IN GREAT LAKES PROPER SURFICIAL SEDIMENTS

Location	No. of Samples	p,p-DDE	p,p-DDD	o,p-DDT	p,p-DDT	DDT	Dieldrin	PCB	Heptachlor Epoxide	Reference
Lower Great Lakes										
Lake Ontario	229	0.013	0.013	0.002	0.016	0.043	-	0.057	-	Frank et al. (1979a)
Lake St. Clair	54	L 0.001	0.002	ND[1]	L 0.001	0.002	-	0.010	L 0.001	Frank et al. (1980)
Bay of Quinte	47	0.010	0.013	ND	0.002	0.026	L 0.001	-	-	
Bay of Quinte	214	-	-	-	-	-	-	0.048	-	Frank et al. (1980)
Lake Erie	259	0.008	0.018	-	0.001	0.028	-	0.095	-	Frank et al. (1977)
Overall Mean		0.008	0.011	0.001	0.005	0.025	L 0.001	0.052	L 0.001	
Upper Great Lakes										
Lake Huron	174	0.003	0.002	L 0.001	0.005	0.010	-	0.013	L 0.001	Frank et al. (1979b)
Georgian Bay	115	0.003	0.002	L 0.001	0.002	0.006	-	0.011	L 0.001	Frank et al. (1979b)
North Channel	55	0.002	L 0.001	L 0.001	0.001	0.004	-	0.008	L 0.001	Frank et al. (1979b)
Lake Huron	9	0.002	L 0.001	L 0.001	0.001	0.004	L 0.001	0.01	-	Glooschenko et al. (1976)
Georgian Bay	7	0.002	0.002	L 0.001	0.002	0.007	L 0.001	0.01	-	Glooschenko et al. (1976)
Lake Superior	17	0.001	L 0.001	L 0.001	L 0.001	0.002	L 0.001	0.02	-	Glooschenko et al. (1976)
Overall Mean		0.002	0.001	L 0.001	0.002	0.005	L 0.001	0.012	L 0.001	

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[1] ND - not detected.

L - less than.

APPENDIX B

Sediment Toxicity Data Supporting Apparent Effects Thresholds

TABLE B-1: PERTINENT TOXICITY DATA SUPPORTING AET FOR COPPER

Ref.[1]	Test Species	Stage	Type	Response		Concentration (ug/g)	
123	H. limbata	nymph	st 10 d	% Surv	0	1,000	
					0	1,100	
					0	2,200	
					0	2,700	
					60	1,800	
					87*	200	
					0	550	
					0	690	
125	H. limbata	nymph	cf 10 d	% Surv	100*	860	AET
					80	930	
59	Chironomus decorus	larvae	st 3 d	% Surv	15	7,533	
					21	7,522	
					45	6,994	
					57	5,909	
					73	4,608	
62	Chironomus tentans	larvae	st 10 d	% Surv	0	2,920	
					0	4,320	
					0	8,870	
					0	10,600	
					7	1,550	
					10	7,650	
					30	4,450	
					40	1,800	
					53	823	
62	Gammarus fasciatus	adult	st 10 d	% Surv	0	1,620	
					0	3,010	
					0	4,190	
					60	936	
62	Hyalella azteca	adult	st 10 d	% Surv	0	1,850	
					0	2,560	
					0	4,070	
62	Chironomus tentans	larvae	st 10 d	% Surv	90*	1,080	AET
					87*	562	
					73	201	

TABLE B-1: PERTINENT TOXICITY DATA SUPPORTING AET FOR COPPER

Ref.[1]	Test Species	Stage	Type	Response	Concentration (ug/g)	
61	*Chironomus decorus*	larvae	st -	EmDay 21*	1,797	AET
94	*Limnodrilus hoffmeisteri*	adult	st -	Rep#/d 0	1,870	
				0.15	150	
				0.45*	40	
94	*Tubifex tubifex*	adult	st -	Rep#/d 0.04	1,870	
				0.30	150	
				0.56*	40	

[1] Reference numbers indexed in Section 7.3.

* Indicates response not significantly different from that of control or lowest concentration.

st = static test
cf = continuous flow
Em = emergence
Rep = reproduction
Surv = survival

TABLE B-2: PERTINENT TOXICITY DATA SUPPORTING AET FOR LEAD

Ref.[1]	Test Species	Stage	Type	Response		Concentration (ug/g)	
84	H. limbata	nymph	st 10 d	% Surv	87*	21	
					80	62	
					47	320	
115	H. limbata	nymph	st 4 d	% Surv	87*	200	AET
					88*	73	
84	Chironomus tentans	larvae	st 10 d	% Surv	13	320	
					60	62	
					77	18	
94	Tubifex tubifex	adult	st -	% Surv	0	1,101	
					45	75	
					70	45	
					90*	215	
119	Pimephales promelas	juvenile	st 4 d	% Surv	98*	330	AET
110	Pontoporeia affinis	adult	st 4 d	% Surv	0	470	
					4	450	
					63	250	
94	Limnodrilus hoffmeisteri	adult	st -	Gr mg/d	0.18*	45	
					0.22*	75	
					0.09	215	
					0.16	1,101	
			st -	Rep#/d	0.45*	45	
					0.15	75	
					0	215	
					0	1,101	
94	Tubifex tubifex	adult	st -	Gr mg/d	0.03	1,101	
					0.09	215	
					0.10	75	
					0.13*	45	
			st -	Rep#/d	0.04	1,101	
					0.24	215	
					0.30	75	
					0.56*	45	

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[1] Reference numbers indexed in Section 7.3.

* Indicates response not significantly different from that of control or lowest concentration.

Gr = growth

Other abbreviations as in Table B-1.

TABLE B-3: PERTINENT TOXICITY DATA SUPPORTING AET FOR ZINC

Ref.[1]	Test Species	Stage	Type	Response		Concentration (ug/g)	
115	H. limbata	nymph	st 4 d	% Surv	87*	920	AET
					80	330	
123	H. limbata	nymph	st 10 d	% Surv	93*	570	
					0	950	
85	T. tubifex/ L. hoffmeisteri	adult	st 4 d	% Surv	98*	1,380	
92	Chironomus tentans	larvae	st 17 d	% Surv	53	4,390	
					70	8,330	
92	Chironomus tentans	larvae	st 17 d	% Surv	70	210	
					45	250	
					90	360	
					0	5,090	
110	Pontoporeia affinis	adult	st 4 d	% Surv	63	1,900	
					0	3,500	
					4	4,700	
110	Salmo gairdneri	juvenile	st 2 d	% Surv	100*	1,900	AET
					17	3,500	
					70	4,700	
112	Chironomus tentans	larvae	st 4 d	% Surv	53	184	
					25	15,100	
92	Chironomus tentans	larvae	st 17 d	Gr mm	18*	77	
					14.5*	4,390	AET
					11.5	8,330	
					8.5	16,400	
					9	17,300	
			st 17 d	Gr mg	2.9*	77	
					1	4,390	
					0.6	8,330	
					0.2	16,400	
					0.5	17,300	
94	Tubifex tubifex	adult	st -	Rep#/d	0.56*	210	
					0.30	250	
					0.24	360	
					0.04	5,090	

TABLE B-3: PERTINENT TOXICITY DATA SUPPORTING AET FOR ZINC

Ref.[1]	Test Species	Stage	Type	Response		Concentration (ug/g)
94	*Limnodrilus hoffmeisteri*	adult	st -	Rep #/d	0.45*	210
					0.15	250
					0	360
					0	5,090
94	*Tubifex tubifex*	adult	st -	Gr mg/d	0.13*	210
					0.10	250
					0.09	360
					0.03	5,090
94	*Limnodrilus hoffmeisteri*	adult	st -	Gr mg/d	0.18*	210
					0.22*	250
					0.09	360
					0.16	5,090
98	*Chironomus tentans*	larvae	st -	% Em	40.5*	77
					12.7	17,300
101	*Chironomus tentans*	larvae	st 5 d	% Av	1.3*	77
					3	184
					3.4	4,395
					6.2	8,330
					24.5	11,134
					48	16,397
					37.1	17,262

[1] Reference numbers indexed in Section 7.3.

* Indicates response not significantly different from that of control or lowest concentration.

Gr = growth
Av = avoidance
Other abbreviations as in Table B-1.

APPENDIX C

Species Screening Level Concentrations and Plots

- SSLC for each species is 90th percentile (P90) concentration all samples with that species present.
- Each table shows SSLCs (P90) for one contaminant, arranged in order of increasing concentration. P95, also shown, has some values missing (-9) due to small sample size.
- A corresponding SLC plot, with the same figure number as the table, shows the rank order of each SSLC against the corresponding SSLC concentration. Plot symbols indicate the number of SSLCs falling at the same plot position. The 5th percentile of this cumulative distribution is the contaminant SLC. (Where fewer than 20 species are included, the 10th percentile is used.)

TABLE C-1: TOC Normalized Species SLC Values for
AS ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
4.74	-9.00	96.00	Helobdella.stagnalis
7.11	10.12	6.00	Aulodrilus.piqueti
7.16	12.34	75.00	Specaria.josinae
9.71	-9.00	9.00	Branchiura.sowerbyi
9.90	-9.00	33.00	Ilyodrilus.templetoni
10.53	-9.00	4.00	Asellus.sp.
10.79	362.31	7.00	Aulodrilus.pleuriseta
10.89	13.02	10.00	Caenis.sp.
10.95	82.85	46.00	Oecetis.sp.
11.06	-9.00	59.00	Pisidium.lilljeborgi
11.49	16.25	85.00	Tubifex.sp.
11.57	32.05	89.00	Valvata.tricarinata
11.64	12.31	35.00	Limnodrilus.sp.
11.74	17.07	88.00	Valvata.sincera
11.76	18.93	34.00	Limnodrilus.hoffmeisteri
11.85	14.00	70.00	Procladius.sp.
11.92	33.88	16.00	Cladotanytarsus.sp.
12.03	-9.00	39.00	Microtendipes.sp.
12.24	-9.00	21.00	Dicrotendipes.sp.
13.24	-9.00	47.00	Parachironomus.sp.
13.27	52.33	49.00	Paratendipes.sp.
13.33	15.97	81.00	Stylaria.lacustris
13.64	23.84	50.00	Phaenopsectra.sp.
14.18	-9.00	36.00	Limnodrilus.udekemianus
14.78	36.15	20.00	Cryptochironomus.sp.
14.92	-9.00	76.00	Sphaerium.nitidum
15.06	71.61	30.00	Hyalella.azteca
15.51	23.56	1.00	Ablabesmyia.sp.
15.51	17.95	65.00	Pontoporeia.hoyi
15.88	32.67	51.00	Phallodrilus.sp.
16.06	-9.00	93.00	Chironomus.plumosus
16.15	385.06	60.00	Pisidium.nitidum
16.52	17.95	61.00	Pisidium.variabile
16.77	89.95	66.00	Potamothrix.moldaviensis
16.85	56.02	58.00	Pisidium.henslowanum
16.88	33.53	64.00	Polypedilum.sp.
17.63	-9.00	56.00	Pisidium.conventus
17.72	169.31	12.00	Chaetogaster.diaphanus
18.03	47.25	54.00	Pisidium.casertanum
18.27	39.35	23.00	Gammarus.fasciatus
18.31	33.15	22.00	Eukiefferiella.sp.
18.40	35.12	43.00	Nais.variabilis
19.53	-9.00	63.00	Polypedilum.scalaenum
20.00	-9.00	15.00	Cladopelma.sp.
20.04	-9.00	28.00	Helisoma.anceps
20.21	74.16	42.00	Nais.communis
20.75	32.12	84.00	Thienemannimyia.sp.
21.12	45.68	18.00	Cricotopus.sp.
21.25	98.61	41.00	Nais.behningi
21.53	45.36	86.00	Turbellaria.sp.indet
22.06	57.87	71.00	Prostoma.rubrum
22.35	61.34	78.00	Spirosperma.ferox
22.96	39.17	44.00	Nanocladius.sp.
23.77	-9.00	27.00	Gyraulus.parvus
23.84	-9.00	73.00	Quistadrilus.multisetosus
24.10	45.36	13.00	Cheumatopsyche.sp.
24.53	52.34	3.00	Amnicola.limosa
26.29	57.87	79.00	Stenonema.sp.
26.39	107.87	53.00	Piguetiella.michiganensis
26.56	74.42	90.00	Vejdovskyella.intermedia
26.69	43.01	32.00	Hydroptila.sp.
27.21	407.89	87.00	Uncinais.uncinata
27.38	68.62	25.00	Glossosoma.sp.
28.11	43.91	82.00	Stylodrilus.heringianus
28.30	60.13	31.00	Hydropsyche.sp.
28.79	89.32	11.00	Ceraclea.sp.
29.50	-9.00	72.00	Pseudocleon.sp.
30.21	75.27	57.00	Pisidium.fallax
30.32	51.71	52.00	Physella.gyrina
30.51	56.74	45.00	Neureclipsis.sp.
30.51	80.06	83.00	Tanytarsus.sp.
32.09	41.00	14.00	Chironomus.sp.
32.51	59.09	74.00	Slavina.appendiculata
32.89	-9.00	2.00	Aeolosoma.sp.
35.95	73.90	62.00	Pleurocera.acuta
36.49	-9.00	55.00	Pisidium.compressum
37.44	82.03	67.00	Potamothrix.vejdovskyi
37.74	83.39	37.00	Lumbriculus.variegatus
40.11	90.77	38.00	Manayunkia.speciosa
49.36	336.02	5.00	Aulodrilus.limnobius
59.09	90.90	77.00	Sphaerium.striatium
67.74	91.29	8.00	Bithynia.tentaculata
78.75	129.94	69.00	Pristina.osborni
184.05	-9.00	29.00	Heterotrissocladius.sp.
199.27	-9.00	48.00	Paralauterborniella.sp.
291.75	-9.00	68.00	Pristina.foreli

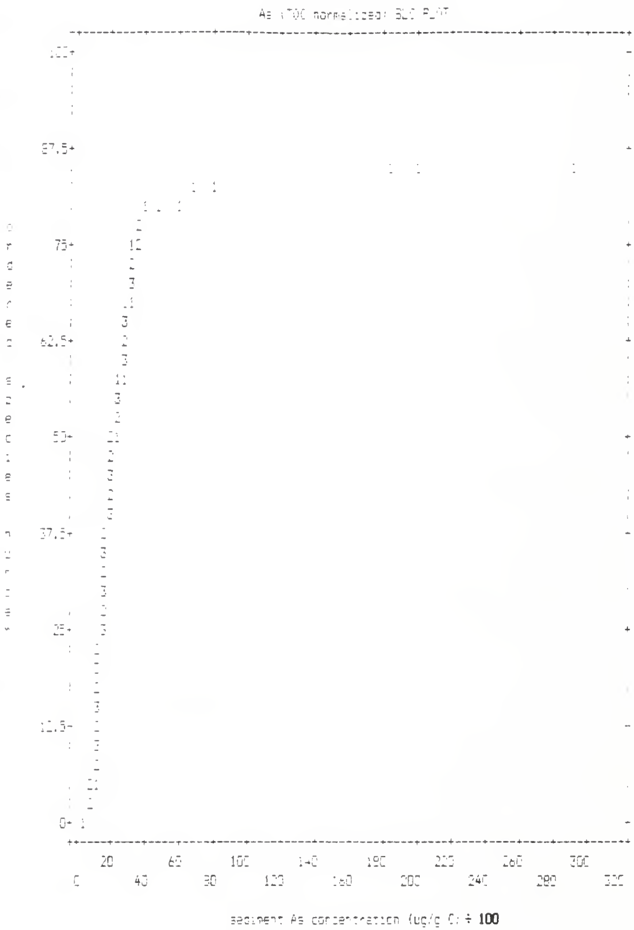

FIGURE C-1: SLC PLOT FOR ARSENIC

TABLE C-2. TOC Normalized Species SLC Values for
Cd ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.58	.80	65.00	Pontoporeia.hoyi
.62	-9.00	59.00	Pisidium.lilljeborgi
.83	-9.00	17.00	Coelotanypus.sp.
.85	-9.00	26.00	Glyptotendipes.sp.
.91	-9.00	80.00	Stictochironomus.sp.
.95	-9.00	76.00	Sphaerium.nitidum
.99	-9.00	9.00	Branchiura.sowerbyi
1.01	42.67	60.00	Pisidium.nitidum
1.10	40.23	7.00	Aulodrilus.pleuriseta
1.13	1.31	89.00	Valvata.tricarinata
1.25	2.07	61.00	Pisidium.variabile
1.33	1.55	51.00	Phallodrilus.sp.
1.37	35.43	5.00	Aulodrilus.limnobius
1.37	3.84	90.00	Vejdovskyella.intermedia
1.39	4.77	10.00	Caenis.sp.
1.42	-9.00	47.00	Parachironomus.sp.
1.45	2.26	88.00	Valvata.sincera
1.47	18.80	12.00	Chaetogaster.diaphanus
1.49	-9.00	39.00	Microtendipes.sp.
1.50	2.21	20.00	Cryptochironomus.sp.
1.51	-9.00	56.00	Pisidium.conventus
1.52	1.76	81.00	Stylaria.lacustris
1.56	1.85	6.00	Aulodrilus.piqueti
1.57	2.45	14.00	Chironomus.sp.
1.58	-9.00	63.00	Polypedilum.scalaenum
1.61	1.95	75.00	Specaria.josinae
1.61	7.33	46.00	Oecetis.sp.
1.68	-9.00	96.00	Helobdella.stagnalis
1.70	12.11	42.00	Nais.communis
1.76	2.56	34.00	Limnodrilus.hoffmeisteri
1.77	-9.00	28.00	Helisoma.anceps
1.83	2.56	8.00	Bithynia.tentaculata
1.83	9.23	66.00	Potamothrix.moldaviensis
1.84	-9.00	33.00	Ilyodrilus.templetoni
1.84	4.54	78.00	Spirosperma.ferox
1.86	8.30	83.00	Tanytarsus.sp.
1.90	2.35	3.00	Amnicola.limosa
1.91	3.22	21.00	Dicrotendipes.sp.
1.96	5.92	54.00	Pisidium.casertanum
2.02	-9.00	15.00	Cladopelma.sp.
2.10	3.06	58.00	Pisidium.henslowanum
2.13	7.74	52.00	Physella.gyrina
2.13	8.42	74.00	Slavina.appendiculata
2.27	5.77	23.00	Gammarus.fasciatus
2.46	-9.00	4.00	Asellus.sp.
2.52	5.86	55.00	Pisidium.compressum
2.56	9.37	43.00	Nais.variabilis
2.57	8.51	38.00	Manayunkia.speciosa
2.60	3.52	92.00	Sphaerium.simile
2.62	8.78	67.00	Potamothrix.vejdovskyi
2.70	7.25	86.00	Turbellaria.sp.indet
3.05	6.59	44.00	Nanocladius.sp.
3.13	-9.00	91.00	Elliptio.complanata
3.18	-9.00	24.00	Glossiphonia.heteroclita
3.23	45.38	87.00	Uncinais.uncinata
3.42	3.94	70.00	Procladius.sp.
3.45	7.58	82.00	Stylodrilus.heringianus
3.48	-9.00	36.00	Limnodrilus.udekemianus
3.58	8.06	45.00	Neureclipsis.sp.
3.60	7.95	71.00	Prostoma.rubrum
3.65	4.00	35.00	Limnodrilus.sp.
3.65	7.36	64.00	Polypedilum.sp.
3.88	6.33	85.00	Tubifex.sp.
4.30	7.79	13.00	Cheumatopsyche.sp.
4.38	-9.00	93.00	Chironomus.plumosus
4.71	6.52	1.00	Ablabesmyia.sp.
4.72	10.38	32.00	Hydroptila.sp.
4.86	7.11	50.00	Phaenopsectra.sp.
5.13	9.89	49.00	Paratendipes.sp.
5.61	8.42	57.00	Pisidium.fallax
5.75	-9.00	73.00	Quistadrilus.multisetosus
5.79	8.35	16.00	Cladotanytarsus.sp.
5.86	-9.00	27.00	Gyraulus.parvus
5.91	8.87	62.00	Pleurocera.acuta
6.00	7.95	22.00	Eukiefferiella.sp.
6.12	-9.00	2.00	Aeolosoma.sp.
6.21	8.05	84.00	Thienemannimyia.sp.
6.32	8.35	11.00	Ceraclea.sp.
6.42	8.95	31.00	Hydropsyche.sp.
6.42	8.42	77.00	Sphaerium.striatium
6.94	8.39	79.00	Stenonema.sp.
7.31	8.11	41.00	Nais.behningi
7.50	9.54	53.00	Piguetiella.michiganensis
7.52	-9.00	72.00	Pseudocloeon.sp.
8.01	9.20	37.00	Lumbriculus.variegatus
8.27	9.40	25.00	Glossosoma.sp.
8.42	11.23	69.00	Pristina.osborni
9.15	13.79	18.00	Cricotopus.sp.
10.74	17.22	30.00	Hyalella.azteca
22.08	-9.00	29.00	Heterotrissocladius.sp.
22.08	-9.00	48.00	Paralauterborniella.sp.
34.05	-9.00	68.00	Pristina.foreli

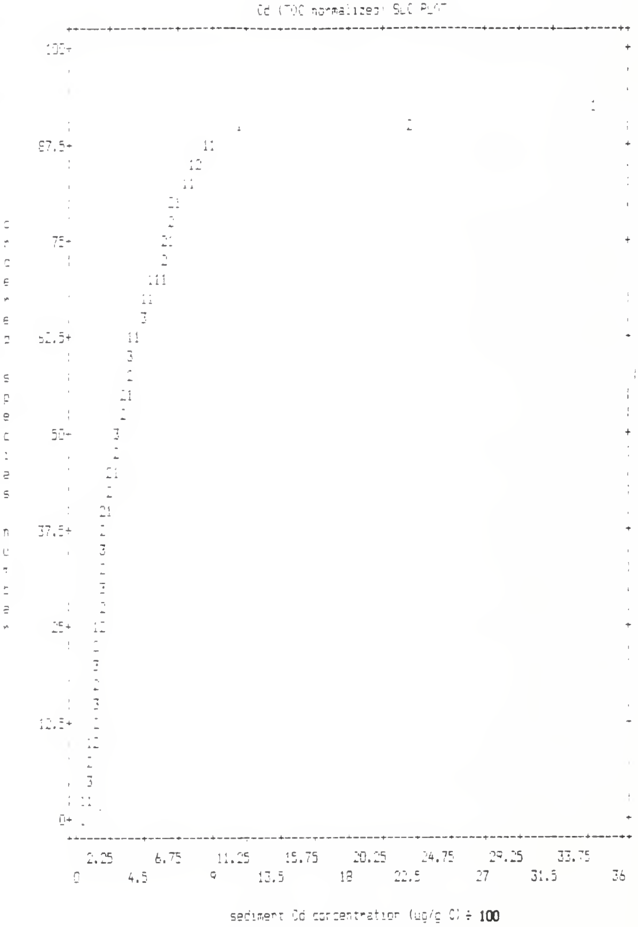

FIGURE C-2: SLC PLOT FOR CADMIUM

TABLE C-3: TOC Normalized Species SLC Values for
Cr ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
17.45	-9.00	96.00	Helobdella.stagnalis
24.25	-9.00	4.00	Asellus.sp.
24.46	-9.00	17.00	Coelotanypus.sp.
27.82	-9.00	59.00	Pisidium.lilljeborgi
40.84	53.15	65.00	Pontoporeia.hoyi
41.77	-9.00	27.00	Gyraulus.parvus
44.82	-9.00	56.00	Pisidium.conventus
45.04	51.81	35.00	Limnodrilus.sp.
48.11	-9.00	47.00	Parachironomus.sp.
48.84	52.03	85.00	Tubifex.sp.
50.53	61.00	10.00	Caenis.sp.
51.02	70.46	61.00	Pisidium.variabile
52.17	75.79	70.00	Procladius.sp.
52.33	75.27	21.00	Dicrotendipes.sp.
52.52	-9.00	9.00	Branchiura.sowerbyi
52.97	-9.00	76.00	Sphaerium.nitidum
54.76	-9.00	80.00	Stictochironomus.sp.
56.69	-9.00	33.00	Ilyodrilus.templetoni
56.96	-9.00	93.00	Chironomus.plumosus
58.64	158.59	46.00	Oecetis.sp.
59.81	680.56	12.00	Chaetogaster.diaphanus
60.00	63.16	88.00	Valvata.sincera
60.37	74.42	6.00	Aulodrilus.piqueti
61.15	87.50	50.00	Phaenopsectra.sp.
61.90	79.74	89.00	Valvata.tricarinata
62.53	123.93	14.00	Chironomus.sp.
62.90	115.56	34.00	Limnodrilus.hoffmeisteri
63.16	81.37	75.00	Specaria.josinae
64.96	-9.00	28.00	Helisoma.anceps
65.26	92.76	20.00	Cryptochironomus.sp.
68.12	1454.29	7.00	Aulodrilus.pleuriseta
69.01	130.48	1.00	Ablabesmyia.sp.
69.34	-9.00	15.00	Cladopelma.sp.
70.12	-9.00	39.00	Microtendipes.sp.
72.44	1541.79	60.00	Pisidium.nitidum
73.33	-9.00	63.00	Polypedilum.scalaenum
77.14	142.65	49.00	Paratendipes.sp.
77.86	158.81	43.00	Nais.variabilis
78.25	189.58	90.00	Vejdovskyella.intermedia
78.33	80.64	81.00	Stylaria.lacustris
78.57	-9.00	36.00	Limnodrilus.udekemianus
78.61	129.90	84.00	Thienemannimyia.sp.
78.91	106.43	64.00	Polypedilum.sp.
80.36	160.81	16.00	Cladotanytarsus.sp.
81.24	196.21	22.00	Eukiefferiella.sp.
83.55	228.76	42.00	Nais.communis
84.66	204.96	53.00	Piguetiella.michiganensis
91.43	310.91	8.00	Bithynia.tentaculata
92.73	141.85	52.00	Physella.gyrina
93.04	143.64	54.00	Pisidium.casertanum
93.50	167.01	32.00	Hydroptila.sp.
97.39	192.83	23.00	Gammarus.fasciatus
97.54	153.74	30.00	Hyalella.azteca
98.75	165.21	58.00	Pisidium.henslowanum
100.00	152.38	78.00	Spirosperma.ferox
101.30	153.02	74.00	Slavina.appendiculata
102.50	-9.00	72.00	Pseudocleon.sp.
108.53	179.35	13.00	Cheumatopsyche.sp.
108.53	179.35	86.00	Turbellaria.sp.indet
109.35	1294.29	5.00	Aulodrilus.limnobius
110.50	233.30	25.00	Glossosoma.sp.
115.00	247.92	3.00	Amnicola.limosa
115.36	236.71	82.00	Stylodrilus.heringianus
116.21	-9.00	55.00	Pisidium.compressum
117.50	149.54	45.00	Neureclipsis.sp.
117.50	192.83	79.00	Stenonema.sp.
117.50	179.35	83.00	Tanytarsus.sp.
118.23	321.39	66.00	Potamothrix.moldaviensis
119.32	249.65	71.00	Prostoma.rubrum
122.00	252.39	51.00	Phallodrilus.sp.
126.50	239.12	11.00	Ceraclea.sp.
127.74	-9.00	73.00	Quistadrilus.multisetosus
130.73	210.00	18.00	Cricotopus.sp.
136.26	246.48	37.00	Lumbriculus.variegatus
141.21	258.33	57.00	Pisidium.fallax
141.76	246.18	44.00	Nanocladius.sp.
141.82	237.21	77.00	Sphaerium.striatium
146.70	322.50	38.00	Manayunkia.speciosa
146.70	322.50	67.00	Potamothrix.vejdovskyi
148.59	274.92	62.00	Pleurocera.acuta
189.46	259.78	41.00	Nais.behningi
196.21	247.14	31.00	Hydropsyche.sp.
205.56	1643.75	87.00	Uncinais.uncinata
210.19	-9.00	2.00	Aeolosoma.sp.
261.56	351.95	69.00	Pristina.osborni
642.25	-9.00	29.00	Heterotrissocladius.sp.
794.55	-9.00	48.00	Paralauterborniella.sp.
1138.43	-9.00	68.00	Pristina.foreli

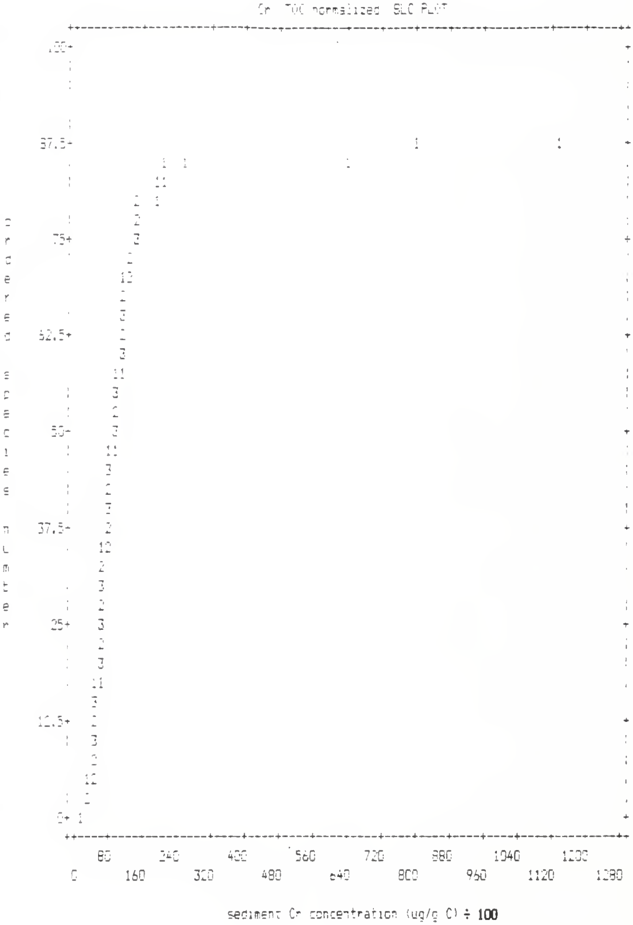

FIGURE C-3: SLC PLOT FOR CHROMIUM

TABLE C-4: TOC Normalized Species SLC Values for
Cu ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
19.70	-9.00	9.00	Branchiura.sowerbyi
19.90	-9.00	26.00	Glyptotendipes.sp.
20.08	-9.00	17.00	Coelotanypus.sp.
21.83	-9.00	39.00	Microtendipes.sp.
23.89	-9.00	59.00	Pisidium.lilljeborgi
25.50	-9.00	4.00	Asellus.sp.
25.50	-9.00	96.00	Helobdella.stagnalis
28.45	-9.00	80.00	Stictochironomus.sp.
28.89	37.25	75.00	Specaria.josinae
29.40	63.54	14.00	Chironomus.sp.
29.66	108.81	46.00	Oecetis.sp.
30.03	34.63	65.00	Pontoporeia.hoyi
30.77	-9.00	76.00	Sphaerium.nitidum
30.77	36.78	88.00	Valvata.sincera
32.49	-9.00	56.00	Pisidium.conventus
32.94	37.13	6.00	Aulodrilus.piqueti
33.67	430.33	60.00	Pisidium.nitidum
33.70	407.11	7.00	Aulodrilus.pleuriseta
33.81	-9.00	27.00	Gyraulus.parvus
34.56	1047.62	10.00	Caenis.sp.
35.00	38.67	61.00	Pisidium.variabile
35.66	73.36	20.00	Cryptochironomus.sp.
35.98	-9.00	47.00	Parachironomus.sp.
36.68	43.37	70.00	Procladius.sp.
37.08	42.82	89.00	Valvata.tricarinata
37.67	40.21	21.00	Dicrotendipes.sp.
39.13	-9.00	24.00	Glossiphonia.heteroclita
39.59	56.06	50.00	Phaenopsectra.sp.
40.00	-9.00	36.00	Limnodrilus.udekemianus
40.46	45.58	81.00	Stylaria.lacustris
40.98	79.23	35.00	Limnodrilus.sp.
41.57	95.06	8.00	Bithynia.tentaculata
42.53	401.43	32.00	Hydroptila.sp.
42.80	111.14	34.00	Limnodrilus.hoffmeisteri
43.19	-9.00	91.00	Elliptio.complanata
43.23	106.45	78.00	Spirosperma.ferox
43.40	100.88	52.00	Physella.gyrina
43.59	95.64	55.00	Pisidium.compressum
44.22	-9.00	15.00	Cladopelma.sp.
44.54	90.10	1.00	Ablabesmyia.sp.
45.86	1273.63	85.00	Tubifex.sp.
46.01	230.11	12.00	Chaetogaster.diaphanus
46.21	102.10	54.00	Pisidium.casertanum
46.64	48.42	49.00	Paratendipes.sp.
47.79	112.40	92.00	Sphaerium.simile
50.07	91.53	51.00	Phallodrilus.sp.
52.07	188.47	67.00	Potamothrix.vejdovskyi
52.38	-9.00	93.00	Chironomus.plumosus
54.63	80.93	58.00	Pisidium.henslowanum
56.77	-9.00	33.00	Ilyodrilus.templetoni
56.96	119.62	64.00	Polypedilum.sp.
57.14	110.00	3.00	Amnicola.limosa
57.46	188.79	43.00	Nais.variabilis
60.11	400.00	53.00	Piguetiella.michiganensis
61.96	175.71	16.00	Cladotanytarsus.sp.
62.44	540.00	42.00	Nais.communis
62.86	107.82	77.00	Sphaerium.striatium
63.10	90.42	90.00	Vejdovskyella.intermedia
65.09	99.83	45.00	Neureclipsis.sp.
66.04	-9.00	63.00	Polypedilum.scalaenum
70.34	-9.00	28.00	Helisoma.anceps
70.59	109.09	30.00	Hyalella.azteca
71.43	159.38	82.00	Stylodrilus.heringianus
74.38	106.59	83.00	Tanytarsus.sp.
78.96	451.43	66.00	Potamothrix.moldaviensis
81.91	143.08	84.00	Thienemannimyia.sp.
84.97	173.06	23.00	Gammarus.fasciatus
85.16	375.71	5.00	Aulodrilus.limnobius
85.34	465.38	74.00	Slavina.appendiculata
89.53	141.88	13.00	Cheumatopsyche.sp.
96.70	407.50	44.00	Nanocladius.sp.
97.17	163.72	25.00	Glossosoma.sp.
100.27	232.45	86.00	Turbellaria.sp.indet
102.02	-9.00	73.00	Quistadrilus.multisetosus
104.86	295.71	11.00	Ceraclea.sp.
104.92	247.86	79.00	Stenonema.sp.
105.09	390.71	38.00	Manayunkia.speciosa
105.64	237.96	57.00	Pisidium.fallax
105.84	197.14	22.00	Eukiefferiella.sp.
106.75	247.86	71.00	Prostoma.rubrum
106.78	480.50	87.00	Uncinais.uncinata
108.62	245.71	62.00	Pleurocera.acuta
108.81	665.71	18.00	Cricotopus.sp.
109.08	-9.00	2.00	Aeolosoma.sp.
125.38	4348.33	41.00	Nais.behningi
132.67	1514.29	31.00	Hydropsyche.sp.
137.18	-9.00	72.00	Pseudocleon.sp.
148.97	461.43	69.00	Pristina.osborni
197.14	2360.00	37.00	Lumbriculus.variegatus
210.00	-9.00	29.00	Heterotrissocladius.sp.
223.18	-9.00	48.00	Paralauterborniella.sp.
311.24	-9.00	68.00	Pristina.foreli

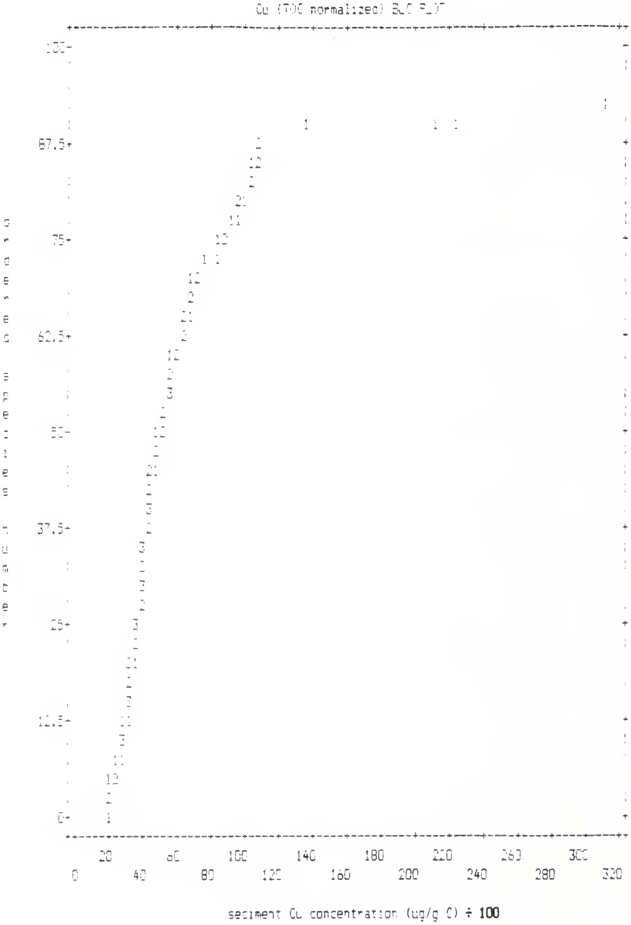

FIGURE C-4: SLC PLOT FOR COPPER

TABLE C-5: TOC Normalized Species SLC Values for
Fe ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
8733.33	-9.00	26.00	Glyptotendipes.sp.
12552.25	-9.00	4.00	Asellus.sp.
13539.09	-9.00	96.00	Helobdella.stagnalis
17541.67	20533.33	35.00	Limnodrilus.sp.
19502.96	-9.00	17.00	Coelotanypus.sp.
20200.00	27529.38	85.00	Tubifex.sp.
30200.86	50423.10	65.00	Pontoporela.hoyi
33104.21	-9.00	59.00	Pisidium.lilljeborgi
35818.18	-9.00	56.00	Pisidium.conventus
36555.55	-9.00	93.00	Chironomus.plumosus
37607.66	-9.00	47.00	Parachironomus.sp.
39111.11	86000.00	21.00	Dicrotendipes.sp.
40542.98	-9.00	27.00	Gyraulus.parvus
43214.29	111383.9	61.00	Pisidium.variabile
45625.43	783404.3	12.00	Chaetogaster.diaphanus
46317.24	-9.00	76.00	Sphaerium.nitidum
46928.52	65473.68	10.00	Caenis.sp.
48016.20	70957.45	70.00	Procladius.sp.
49804.51	1690286	7.00	Aulodrilus.pleuriseta
50239.23	82500.00	1.00	Ablabesmyia.sp.
51283.45	-9.00	63.00	Polypedilum.scalaenum
52570.53	71373.01	88.00	Valvata.sincera
54233.77	141491.3	49.00	Paratendipes.sp.
55046.38	144196.4	14.00	Chironomus.sp.
57058.82	88181.82	30.00	Hyalella.azteca
59558.82	-9.00	9.00	Branchiura.sowerbyi
62468.11	92879.26	20.00	Cryptochironomus.sp.
62767.86	135128.5	34.00	Limnodrilus.hoffmeisteri
63851.35	77724.33	6.00	Aulodrilus.piqueti
64794.27	95877.66	50.00	Phaenopsectra.sp.
65162.70	-9.00	80.00	Stictochironomus.sp.
65625.00	78538.39	75.00	Specaria.josinae
66666.66	-9.00	36.00	Limnodrilus.udekemianus
67083.34	110476.2	16.00	Cladotanytarsus.sp.
69162.23	-9.00	33.00	Ilyodrilus.templetoni
70799.42	-9.00	28.00	Helisoma.anceps
72330.53	216844.0	46.00	Oecetis.sp.
73518.06	82245.99	89.00	Valvata.tricarinata
74583.34	-9.00	73.00	Quistadrilus.multisetosus
75624.06	-9.00	39.00	Microtendipes.sp.
77067.91	149808.7	55.00	Pisidium.compressum
81454.55	93094.73	81.00	Stylaria.lacustris
81604.61	-9.00	15.00	Cladopelma.sp.
81627.91	1797857	60.00	Pisidium.nitidum
82597.41	169196.2	43.00	Nais.variabilis
83137.26	356486.2	66.00	Potamothrix.moldaviensis
85093.17	117142.9	64.00	Polypedilum.sp.
86832.30	148664.0	84.00	Thienemannimyia.sp.
88544.89	211823.3	90.00	Vejdovskyella.intermedia
90114.29	189391.9	78.00	Spirosperma.ferox
91428.57	290730.3	67.00	Potamothrix.vejdovskyi
91443.48	217857.1	23.00	Gammarus.fasciatus
91443.48	145973.8	54.00	Pisidium.casertanum
91791.30	229133.3	51.00	Phallodrilus.sp.
92000.00	145833.3	3.00	Amnicola.limosa
92677.34	277153.6	53.00	Piguetiella.michiganensis
93277.31	229375.0	58.00	Pisidium.henslowanum
93554.98	196483.5	22.00	Eukiefferiella.sp.
93694.12	145927.0	52.00	Physella.gyrina
94285.71	231351.3	8.00	Bithynia.tentaculata
94303.41	189065.9	86.00	Turbellaria.sp.indet
94551.09	281333.3	71.00	Prostoma.rubrum
98421.05	195000.0	79.00	Stenonema.sp.
99846.49	243764.0	42.00	Nais.communis
108150.0	156300.2	32.00	Hydroptila.sp.
109166.7	301333.3	57.00	Pisidium.fallax
111925.5	1512857	5.00	Aulodrilus.limnobius
112857.1	220142.9	13.00	Cheumatopsyche.sp.
115384.6	281282.1	41.00	Nais.behningi
118655.5	157631.8	74.00	Slavina.appendiculata
118797.0	235336.5	44.00	Nanocladius.sp.
119975.5	-9.00	72.00	Pseudocleon.sp.
121428.6	241071.4	82.00	Stylodrilus.heringianus
129283.3	-9.00	24.00	Glossiphonia.heteroclita
135801.3	229904.8	18.00	Cricotopus.sp.
137983.2	212802.2	25.00	Glossosoma.sp.
137983.2	182688.0	83.00	Tanytarsus.sp.
143750.0	151849.6	45.00	Neureclipsis.sp.
144047.6	248928.6	62.00	Pleurocera.acuta
145856.7	399375.0	38.00	Manayunkia.speciosa
149001.1	245337.8	92.00	Sphaerium.simile
149711.5	257333.3	11.00	Ceraclea.sp.
159560.4	238095.2	37.00	Lumbriculus.variegatus
167520.6	365833.3	77.00	Sphaerium.striatium
196483.5	344166.7	31.00	Hydropsyche.sp.
205384.6	397727.3	69.00	Pristina.osborni
231351.3	-9.00	91.00	Elliptio.complanata
306346.2	-9.00	2.00	Aeolosoma.sp.
354260.2	2014375	87.00	Uncinais.uncinata
732247.2	-9.00	29.00	Heterotrissocladius.sp
916363.6	-9.00	48.00	Paralauterborniella.sp.
1318427	-9.00	68.00	Pristina.foreli

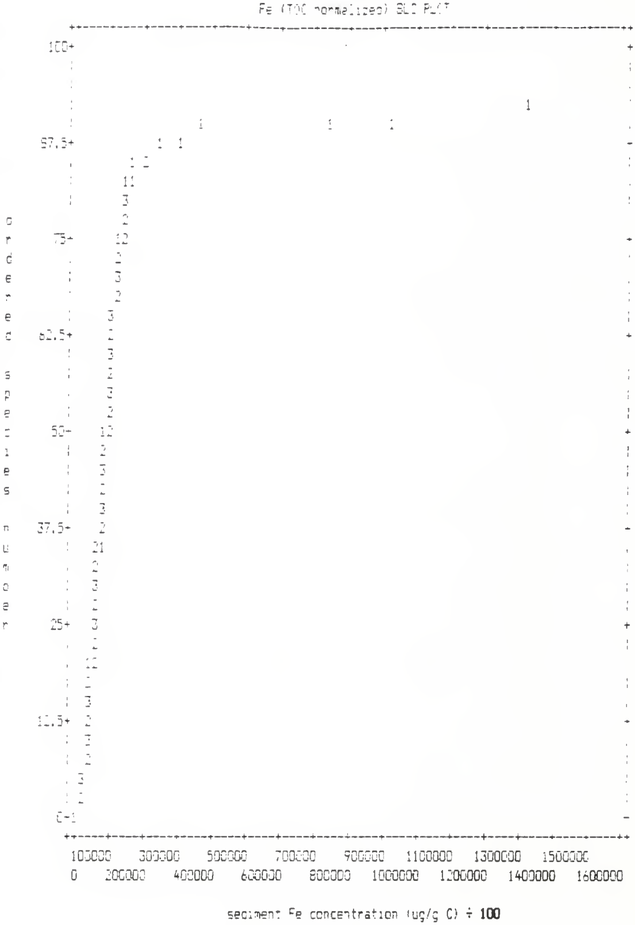

FIGURE C-5: SLC PLOT FOR IRON

TABLE C-6: TOC Normalized Species SLC Values for Pb ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
22.21	-9.00	9.00	Branchiura.sowerbyi
24.21	-9.00	59.00	Pisidium.lilljeborgi
29.16	-9.00	76.00	Sphaerium.nitidum
29.23	-9.00	17.00	Coelotanypus.sp.
29.43	37.35	65.00	Pontoporeia.hoyi
32.84	-9.00	80.00	Stictochironomus.sp.
38.16	-9.00	26.00	Glyptotendipes.sp.
41.50	-9.00	56.00	Pisidium.conventus
42.96	-9.00	63.00	Polypedilum.scalaenum
58.88	-9.00	28.00	Helisoma.anceps
59.58	63.56	21.00	Dicrotendipes.sp.
60.35	-9.00	91.00	Elliptio.complanata
60.74	-9.00	4.00	Asellus.sp.
60.74	-9.00	96.00	Helobdella.stagnalis
61.36	73.89	10.00	Caenis.sp.
61.91	80.42	35.00	Limnodrilus.sp.
62.12	-9.00	24.00	Glossiphonia.heteroclita
63.46	86.01	14.00	Chironomus.sp.
63.54	152.79	85.00	Tubifex.sp.
63.71	101.17	70.00	Procladius.sp.
68.34	91.06	20.00	Cryptochironomus.sp.
68.66	1711.40	60.00	Pisidium.nitidum
69.03	206.86	1.00	Ablabesmyia.sp.
70.24	382.43	42.00	Nais.communis
71.46	90.69	89.00	Valvata.tricarinata
71.50	157.35	84.00	Thienemannimyia.sp.
72.97	90.67	49.00	Paratendipes.sp.
73.10	-9.00	47.00	Parachironomus.sp.
73.34	157.39	53.00	Piguetiella.michiganensis
74.05	-9.00	27.00	Gyraulus.parvus
76.00	169.23	83.00	Tanytarsus.sp.
77.46	140.31	46.00	Oecetis.sp.
77.80	89.08	88.00	Valvata.sincera
77.83	154.02	81.00	Stylaria.lacustris
77.87	148.87	64.00	Polypedilum.sp.
78.26	233.00	75.00	Specaria.josinae
80.34	200.03	45.00	Neureclipsis.sp.
80.65	328.21	6.00	Aulodrilus.piqueti
81.24	95.24	61.00	Pisidium.variabile
83.03	121.33	8.00	Bithynia.tentaculata
83.86	-9.00	39.00	Microtendipes.sp.
84.92	157.16	34.00	Limnodrilus.hoffmeisteri
85.38	226.50	50.00	Phaenopsectra.sp.
87.36	124.76	66.00	Potamothrix.moldaviensis
89.95	325.19	55.00	Pisidium.compressum
96.57	-9.00	93.00	Chironomus.plumosus
97.38	262.27	67.00	Potamothrix.vejdovskyi
98.22	243.60	54.00	Pisidium.casertanum
100.04	-9.00	72.00	Pseudocleon.sp.
100.08	308.42	32.00	Hydroptila.sp.
103.60	600.33	92.00	Sphaerium.simile
104.59	300.66	43.00	Nais.variabilis
106.84	164.90	74.00	Slavina.appendiculata
107.83	194.73	23.00	Gammarus.fasciatus
109.58	163.92	82.00	Stylodrilus.heringianus
111.01	-9.00	33.00	Ilyodrilus.templetoni
111.33	154.02	52.00	Physella.gyrina
111.57	226.50	90.00	Veejdovskyella.intermedia
114.10	237.08	78.00	Spirosperma.ferox
123.81	-9.00	36.00	Limnodrilus.udekemianus
125.00	163.04	3.00	Amnicola.limosa
127.73	-9.00	73.00	Quistadrilus.multisetosus
128.09	200.43	86.00	Turbellaria.sp.indet
128.61	699.38	58.00	Pisidium.henslowanum
131.66	202.46	16.00	Cladotanytarsus.sp.
136.57	189.03	11.00	Ceraclea.sp.
137.03	943.48	12.00	Chaetogaster.diaphanus
137.84	341.78	57.00	Pisidium.fallax
137.84	400.61	77.00	Sphaerium.striatium
140.38	406.23	62.00	Pleurocera.acuta
140.74	249.17	79.00	Stenonema.sp.
141.10	372.53	71.00	Prostoma.rubrum
141.65	348.80	44.00	Nanocladius.sp.
145.48	371.90	13.00	Cheumatopsyche.sp.
152.94	228.92	22.00	Eukiefferiella.sp.
152.94	228.41	30.00	Hyalella.azteca
156.49	220.95	37.00	Lumbriculus.variegatus
161.85	291.60	25.00	Glossosoma.sp.
162.44	290.39	18.00	Cricotopus.sp.
173.46	257.41	41.00	Nais.behningi
176.47	685.46	38.00	Manayunkia.speciosa
228.92	474.64	31.00	Hydropsyche.sp.
252.51	362.98	51.00	Phallodrilus.sp.
261.32	1674.92	7.00	Aulodrilus.pleuriseta
263.11	519.35	69.00	Pristina.osborni
305.02	-9.00	15.00	Cladopelma.sp.
316.01	1563.64	5.00	Aulodrilus.limnobius
627.47	-9.00	29.00	Heterotrissocladius.sp.
750.68	-9.00	2.00	Aeolosoma.sp.
887.50	-9.00	87.00	Uncinais.uncinata
1024.75	-9.00	48.00	Paralauterborniella.sp.
1318.92	-9.00	68.00	Pristina.foreli

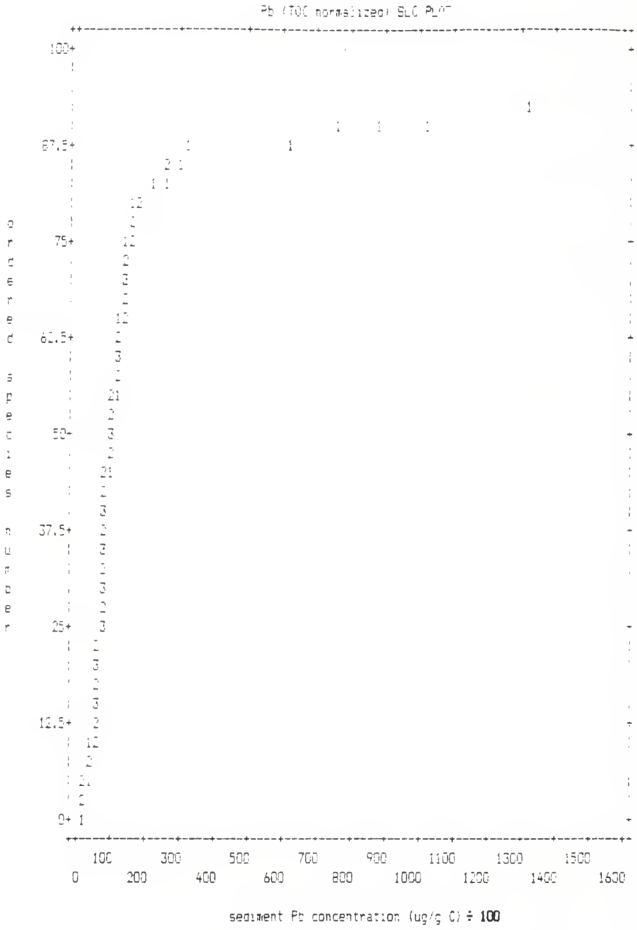

FIGURE C-6: SLC PLOT FOR LEAD

TABLE C-7: TOC Normalized Species SLC Values for
Mn ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
265.54	303.89	70.00	Procladius.sp.
289.33	359.68	35.00	Limnodrilus.sp.
291.17	475.77	85.00	Tubifex.sp.
323.05	988.57	23.00	Gammarus.fasciatus
335.50	361.66	64.00	Polypedilum.sp.
359.56	-9.00	46.00	Oecetis.sp.
362.42	-9.00	4.00	Asellus.sp.
362.42	-9.00	96.00	Helobdella.stagnalis
367.50	-9.00	9.00	Branchiura.sowerbyi
480.09	-9.00	20.00	Cryptochironomus.sp.
481.78	-9.00	93.00	Chironomus.plumosus
615.92	1088.82	14.00	Chironomus.sp.
5465.24	6636.36	30.00	Hyalella.azteca
6636.36	-9.00	18.00	Cricotopus.sp.

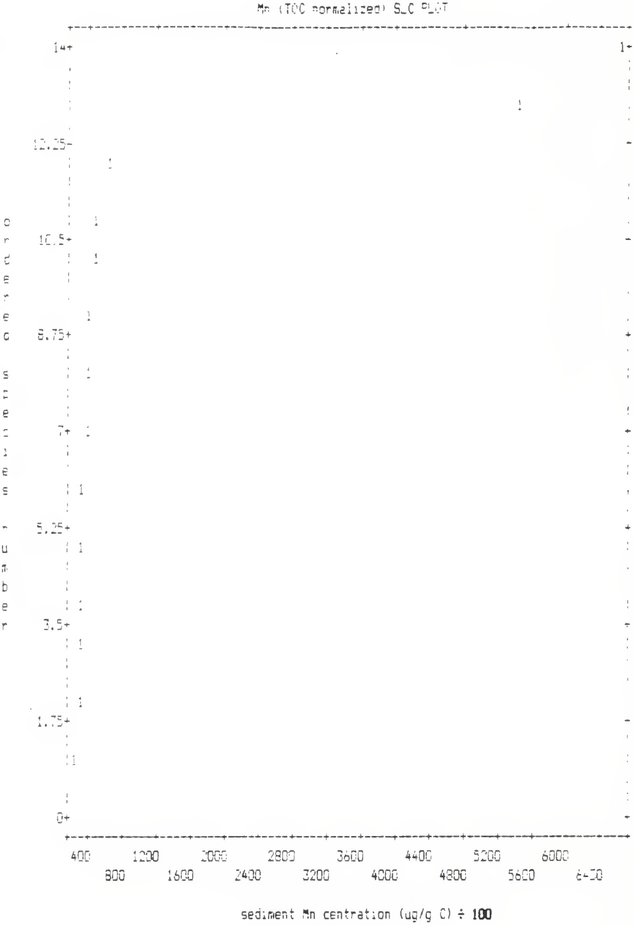

FIGURE C-7: SLC PLOT FOR MANGANESE

TABLE C-8. TOC Normalized Species SLC Values for
Hg ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.07	-9.00	63.00	Polypedilum.scalaenum
.10	-9.00	56.00	Pisidium.conventus
.11	-9.00	91.00	Elliptio.complanata
.11	.31	92.00	Sphaerium.simile
.12	.13	65.00	Pontoporeia.hoyi
.12	-9.00	93.00	Chironomus.plumosus
.13	-9.00	9.00	Branchiura.sowerbyi
.19	-9.00	59.00	Pisidium.lilljeborgi
.19	-9.00	26.00	Glyptotendipes.sp.
.23	.38	61.00	Pisidium.variabile
.25	-9.00	76.00	Sphaerium.nitidum
.26	.43	85.00	Tubifex.sp.
.27	.57	84.00	Thienemannimyia.sp.
.35	.38	35.00	Limnodrilus.sp.
.38	.57	22.00	Eukiefferiella.sp.
.39	.46	30.00	Hyalella.azteca
.41	1.11	52.00	Physella.gyrina
.44	1.47	45.00	Neureclipsis.sp.
.47	-9.00	27.00	Gyraulus.parvus
.48	6.08	12.00	Chaetogaster.diaphanus
.49	.69	58.00	Pisidium.henslowanum
.49	2.07	90.00	Vejdovskyella.intermedia
.50	13.68	60.00	Pisidium.nitidum
.50	1.63	49.00	Paratendipes.sp.
.50	.87	70.00	Procladius.sp.
.51	.63	41.00	Nais.behningi
.51	2.51	8.00	Bithynia.tentaculata
.51	.93	55.00	Pisidium.compressum
.51	.71	64.00	Polypedilum.sp.
.51	1.25	25.00	Glossosoma.sp.
.52	.59	50.00	Phaenopsectra.sp.
.52	2.72	46.00	Oecetis.sp.
.55	1.17	20.00	Cryptochironomus.sp.
.55	.82	82.00	Stylodrilus.heringianus
.56	1.10	79.00	Stenonema.sp.
.56	1.20	89.00	Valvata.tricarinata
.57	.96	31.00	Hydropsyche.sp.
.57	1.24	78.00	Spirosperma.ferox
.58	-9.00	17.00	Coelotanypus.sp.
.59	1.09	54.00	Pisidium.casertanum
.59	1.25	11.00	Ceraclea.sp.
.61	1.04	13.00	Cheumatopsyche.sp.
.61	1.26	14.00	Chironomus.sp.
.62	1.14	10.00	Caenis.sp.
.62	1.16	23.00	Gammarus.fasciatus
.63	1.45	18.00	Cricotopus.sp.
.65	1.87	1.00	Ablabesmyia.sp.
.65	2.40	42.00	Nais.communis
.66	1.06	71.00	Prostoma.rubrum
.68	1.43	83.00	Tanytarsus.sp.
.69	1.21	34.00	Limnodrilus.hoffmeisteri
.69	1.00	81.00	Stylaria.lacustris
.70	12.42	53.00	Piguetiella.michiganensis
.70	1.31	86.00	Turbellaria.sp.indet
.72	.96	51.00	Phallodrilus.sp.
.74	9.20	75.00	Specaria.josinae
.74	1.10	88.00	Valvata.sincera
.74	-9.00	2.00	Aeolosoma.sp.
.75	1.49	62.00	Pleurocera.acuta
.79	1.56	16.00	Cladotanytarsus.sp.
.79	-9.00	72.00	Pseudocleon.sp.
.81	1.31	37.00	Lumbriculus.variegatus
.82	1.55	43.00	Nais.variabilis
.88	1.25	3.00	Amnicola.limosa
.88	-9.00	87.00	Uncinais.uncinata
.90	13.00	7.00	Aulodrilus.pleuriseta
.90	2.45	57.00	Pisidium.fallax
.90	1.58	77.00	Sphaerium.striatium
.94	1.30	44.00	Nanocladius.sp.
.95	7.71	6.00	Aulodrilus.piqueti
.96	-9.00	73.00	Quistadrilus.multisetosus
.97	-9.00	28.00	Helisoma.anceps
1.01	11.63	5.00	Aulodrilus.limnobius
1.10	-9.00	47.00	Parachironomus.sp.
1.20	2.76	69.00	Pristina.osborni
1.21	3.78	38.00	Manayunkia.speciosa
1.26	4.04	32.00	Hydroptila.sp.
1.29	4.06	66.00	Potamothrix.moldaviensis
1.30	-9.00	4.00	Asellus.sp.
1.36	6.40	74.00	Slavina.appendiculata
1.45	3.71	67.00	Potamothrix.vejdovskyi
2.04	-9.00	96.00	Helobdella.stagnalis
2.87	-9.00	15.00	Cladopelma.sp.
3.36	14.88	21.00	Dicrotendipes.sp.
3.40	-9.00	39.00	Microtendipes.sp.
3.56	-9.00	24.00	Glossiphonia.heteroclita
3.90	-9.00	80.00	Stictochironomus.sp.
4.33	-9.00	36.00	Limnodrilus.udekemianus
5.98	-9.00	29.00	Heterotrissocladius.sp.
7.71	-9.00	33.00	Ilyodrilus.templetoni
8.17	-9.00	48.00	Paralauterborniella.sp.
10.27	-9.00	68.00	Pristina.foreli

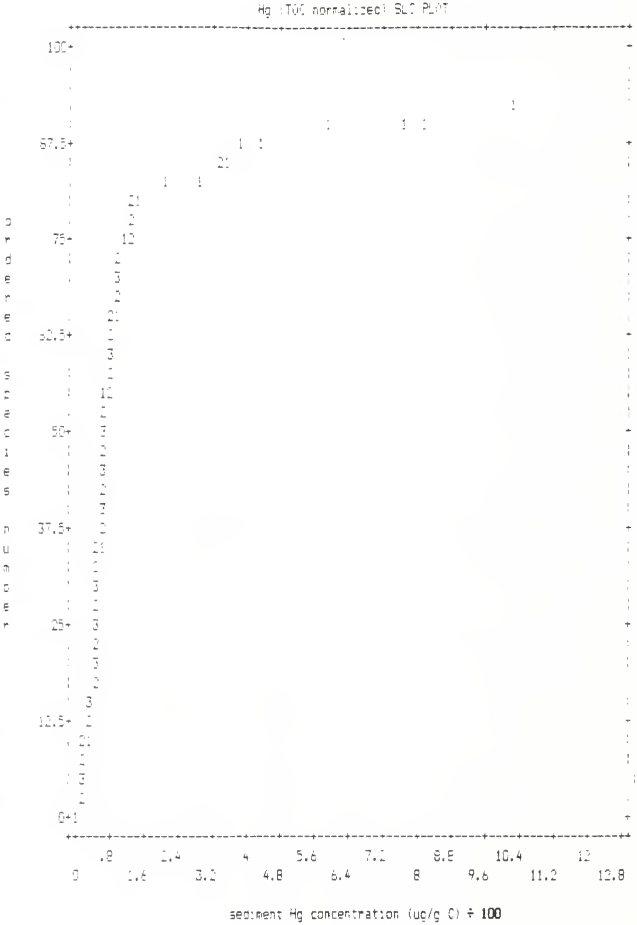

FIGURE C-8: SLC PLOT FOR MERCURY

TABLE C-9: TOC Normalized Species SLC Values for Ni ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
15.91	-9.00	59.00	Pisidium.lilljeborgi
20.42	-9.00	17.00	Coelotanypus.sp.
21.58	-9.00	47.00	Parachironomus.sp.
22.00	-9.00	56.00	Pisidium.conventus
23.97	53.01	35.00	Limnodrilus.sp.
24.40	31.08	61.00	Pisidium.variabile
26.30	61.63	85.00	Tubifex.sp.
27.43	105.47	65.00	Pontoporeia.hoyi
29.02	-9.00	80.00	Stictochironomus.sp.
35.40	-9.00	28.00	Helisoma.anceps
37.90	200.15	75.00	Specaria.josinae
37.93	339.68	21.00	Dicrotendipes.sp.
37.99	44.08	70.00	Procladius.sp.
38.20	-9.00	63.00	Polypedilum.scalaenum
38.26	-9.00	27.00	Gyraulus.parvus
38.76	185.13	46.00	Oecetis.sp.
39.42	43.85	10.00	Caenis.sp.
39.45	169.36	66.00	Potamothrix.moldaviensis
39.80	169.06	6.00	Aulodrilus.piqueti
41.09	116.88	34.00	Limnodrilus.hoffmeisteri
41.45	-9.00	76.00	Sphaerium.nitidum
42.08	75.27	50.00	Phaenopsectra.sp.
42.68	486.92	12.00	Chaetogaster.diaphanus
42.75	63.65	1.00	Ablabesmyia.sp.
42.96	936.95	7.00	Aulodrilus.pleuriseta
42.96	53.09	89.00	Valvata.tricarinata
43.09	67.41	20.00	Cryptochironomus.sp.
44.83	47.37	88.00	Valvata.sincera
47.02	81.35	49.00	Paratendipes.sp.
51.30	86.64	22.00	Eukiefferiella.sp.
52.82	120.00	16.00	Cladotanytarsus.sp.
54.07	-9.00	9.00	Branchiura.sowerbyi
55.27	180.71	42.00	Nais.communis
56.97	114.69	54.00	Pisidium.casertanum
57.05	-9.00	4.00	Asellus.sp.
57.05	82.35	81.00	Stylaria.lacustris
57.05	-9.00	96.00	Helobdella.stagnalis
59.36	97.31	84.00	Thienemannimyia.sp.
59.87	-9.00	73.00	Quistadrilus.multisetosus
59.89	89.66	64.00	Polypedilum.sp.
61.82	83.09	52.00	Physella.gyrina
63.03	150.78	71.00	Prostoma.rubrum
63.81	95.59	51.00	Phallodrilus.sp.
66.67	129.17	78.00	Spirosperma.ferox
67.78	-9.00	55.00	Pisidium.compressum
68.03	97.47	14.00	Chironomus.sp.
69.02	147.69	3.00	Amnicola.limosa
69.41	110.21	23.00	Gammarus.fasciatus
71.82	132.25	11.00	Ceraclea.sp.
71.91	104.38	86.00	Turbellaria.sp.indet
72.50	105.21	79.00	Stenonema.sp.
74.56	510.63	58.00	Pisidium.henslowanum
77.36	104.38	13.00	Cheumatopsyche.sp
78.12	144.42	90.00	Vejdovskyella.intermedia
79.79	99.62	25.00	Glossosoma.sp.
82.35	842.00	5.00	Aulodrilus.limnobius
82.92	256.36	57.00	Pisidium.fallax
82.94	163.13	32.00	Hydroptila.sp.
82.94	115.92	43.00	Nais.variabilis
83.45	1001.00	60.00	Pisidium.nitidum
83.80	124.72	82.00	Stylodrilus.heringianus
84.83	150.00	67.00	Potamothrix.vejdovskyi
86.64	442.50	31.00	Hydropsyche.sp.
86.67	172.73	8.00	Bithynia.tentaculata
86.81	141.51	62.00	Pleurocera.acuta
87.58	-9.00	39.00	Microtendipes.sp.
88.20	261.82	77.00	Sphaerium.striatium
88.64	176.67	74.00	Slavina.appendiculata
90.67	-9.00	72.00	Pseudocleon.sp.
91.57	341.67	53.00	Piguetiella.michiganensis
94.62	230.00	41.00	Nais.behningi
94.62	104.38	45.00	Neureclipsis.sp.
95.39	140.00	37.00	Lumbriculus.variegatus
95.39	163.33	83.00	Tanytarsus.sp.
96.15	328.13	44.00	Nanocladius.sp.
100.00	-9.00	36.00	Limnodrilus.udekemianus
100.00	525.91	38.00	Manayunkia.speciosa
113.00	223.64	18.00	Cricotopus.sp.
118.11	283.64	69.00	Pristina.osborni
118.17	-9.00	93.00	Chironomus.plumosus
151.81	-9.00	15.00	Cladopelma.sp.
169.06	-9.00	33.00	Ilyodrilus.templetoni
243.85	282.27	30.00	Hyalella.azteca
418.00	-9.00	29.00	Heterotrissocladius.sp.
578.54	-9.00	48.00	Paralauterborniella.sp.
644.42	-9.00	2.00	Aeolosoma.sp.
729.26	-9.00	68.00	Pristina.foreli
1012.50	-9.00	87.00	Uncinais.uncinata

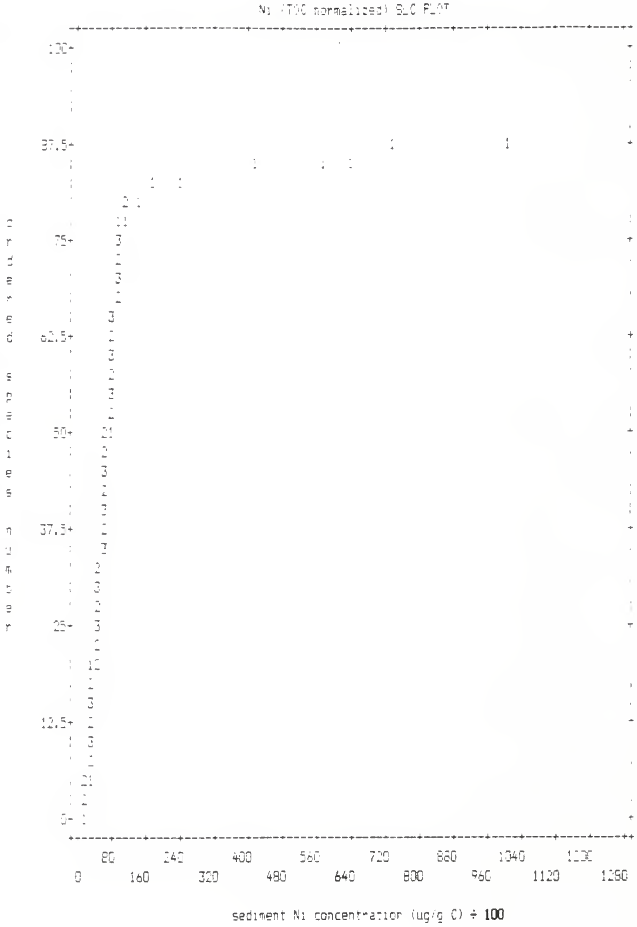

FIGURE C-9: SLC PLOT FOR NICKEL

TABLE C-10: TOC Normalized Species SLC Values for
Zn ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
67.15	-9.00	26.00	Glyptotendipes.sp.
106.36	-9.00	17.00	Coelotanypus.sp.
127.95	-9.00	59.00	Pisidium.lilljeborgi
139.70	-9.00	56.00	Pisidium.conventus
141.41	179.68	65.00	Pontoporeia.hoyi
156.61	-9.00	63.00	Polypedilum.scalaenum
164.44	240.18	61.00	Pisidium.variabile
165.11	-9.00	24.00	Glossiphonia.heteroclita
165.87	-9.00	76.00	Sphaerium.nitidum
175.07	278.83	85.00	Tubifex.sp.
176.36	494.87	35.00	Limnodrilus.sp.
183.95	196.07	92.00	Sphaerium.simile
185.82	-9.00	80.00	Stictochironomus.sp.
189.06	415.24	1.00	Ablabesmyia.sp.
194.98	-9.00	91.00	Elliptio.complanata
196.21	475.17	70.00	Procladius.sp.
198.16	3618.16	12.00	Chaetogaster.diaphanus
244.14	396.25	34.00	Limnodrilus.hoffmeisteri
244.87	-9.00	47.00	Parachironomus.sp.
268.30	8375.35	60.00	Pisidium.nitidum
268.46	-9.00	4.00	Asellus.sp.
268.46	-9.00	96.00	Helobdella.stagnalis
268.77	461.65	55.00	Pisidium.compressum
270.18	444.21	88.00	Valvata.sincera
273.16	-9.00	9.00	Branchiura.sowerbyi
293.34	-9.00	28.00	Helisoma.anceps
295.68	528.87	8.00	Bithynia.tentaculata
296.02	385.00	81.00	Stylaria.lacustris
297.19	380.00	50.00	Phaenopsectra.sp.
297.76	394.29	89.00	Valvata.tricarinata
298.41	7914.29	7.00	Aulodrilus.pleuriseta
298.90	532.23	78.00	Spirosperma.ferox
301.05	1022.26	10.00	Caenis.sp.
308.32	463.08	21.00	Dicrotendipes.sp.
333.45	787.27	90.00	Vejdovskyella.intermedia
353.17	750.94	58.00	Pisidium.henslowanum
355.20	553.16	20.00	Cryptochironomus.sp.
357.35	641.78	14.00	Chironomus.sp.
371.43	477.70	75.00	Specaria.josinae
373.68	476.94	6.00	Aulodrilus.piqueti
395.00	1220.00	64.00	Polypedilum.sp.
400.00	480.00	3.00	Amnicola.limosa
400.00	1153.85	83.00	Tanytarsus.sp.
402.19	470.50	51.00	Phallodrilus.sp.
407.62	-9.00	73.00	Quistadrilus.multisetosus
408.15	-9.00	15.00	Cladopelma.sp.
413.65	-9.00	33.00	Ilyodrilus.templetoni
422.92	2640.94	42.00	Nais.communis
428.74	7057.14	5.00	Aulodrilus.limnobius
435.71	998.57	66.00	Potamothrix.moldaviensis
444.73	-9.00	93.00	Chironomus.plumosus
464.00	1639.05	52.00	Physella.gyrina
474.37	1157.03	23.00	Gammarus.fasciatus
475.13	1147.79	54.00	Pisidium.casertanum
476.19	-9.00	36.00	Limnodrilus.udekemianus
482.20	1572.05	16.00	Cladotanytarsus.sp.
494.92	1072.50	38.00	Manayunkia.speciosa
514.04	-9.00	39.00	Microtendipes.sp.
525.80	1503.79	32.00	Hydroptila.sp.
525.80	1241.43	43.00	Nais.variabilis
551.52	1295.71	86.00	Turbellaria.sp.indet
568.57	1075.96	44.00	Nanocladius.sp.
570.12	806.15	74.00	Slavina.appendiculata
603.43	1157.89	49.00	Paratendipes.sp.
632.01	1695.67	67.00	Potamothrix.vejdovskyi
637.59	1320.39	45.00	Neureclipsis.sp.
656.49	1890.28	46.00	Oecetis.sp.
823.53	1272.73	30.00	Hyalella.azteca
853.57	1392.86	82.00	Stylodrilus.heringianus
886.88	1698.33	71.00	Prostoma.rubrum
1031.27	2663.00	53.00	Piguetiella.michiganensis
1050.00	-9.00	87.00	Uncinais.uncinata
1058.18	1887.62	57.00	Pisidium.fallax
1081.15	1546.91	13.00	Cheumatopsyche.sp.
1109.87	1887.62	77.00	Sphaerium.striatium
1112.31	-9.00	2.00	Aeolosoma.sp.
1116.08	2205.21	62.00	Pleurocera.acuta
1166.59	1303.81	31.00	Hydropsyche.sp.
1179.34	1736.19	22.00	Eukiefferiella.sp.
1194.29	2194.16	11.00	Ceraclea.sp.
1245.71	2216.26	79.00	Stenonema.sp.
1247.91	1639.83	18.00	Cricotopus.sp.
1260.00	2238.36	84.00	Thienemannimyia.sp.
1336.19	2375.42	37.00	Lumbriculus.variegatus
1349.19	-9.00	27.00	Gyraulus.parvus
1384.76	2737.06	69.00	Pristina.osborni
1417.14	2260.47	25.00	Glossosoma.sp.
1660.48	2238.36	41.00	Nais.behningi
2542.33	-9.00	72.00	Pseudocleon.sp.
3400.00	-9.00	29.00	Heterotrissocladius.sp.
5234.29	-9.00	48.00	Paralauterborniella.sp.
6131.69	-9.00	68.00	Pristina.foreli

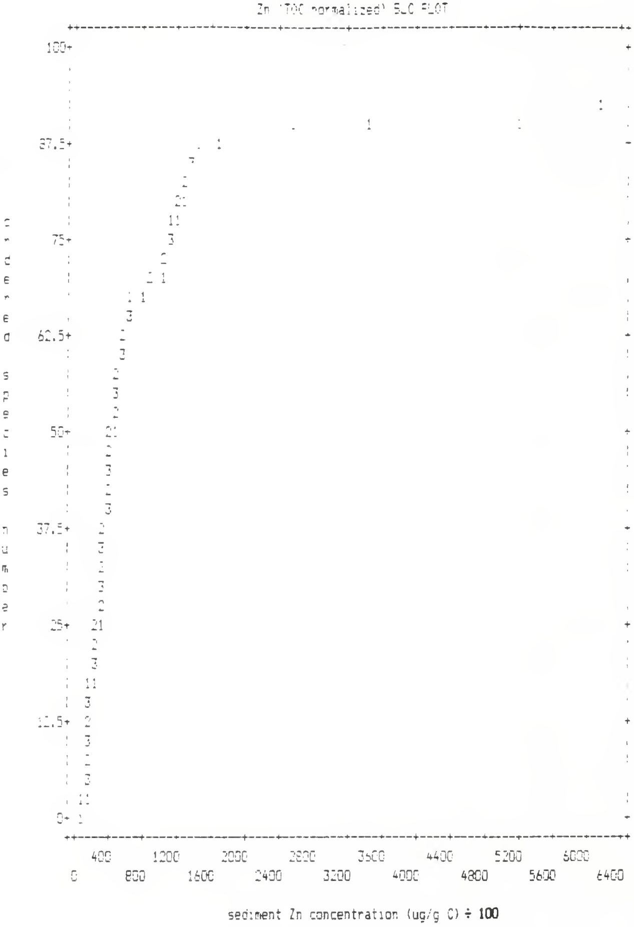

FIGURE C-10: SLC PLOT FOR ZINC

TABLE C-11: TOC Normalized Species SLC Values for
Heptachlor ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.002	.01	65.00	Pontoporeia.hoyi
.002	-9.00	66.00	Potamothrix.moldaviensis
.002	-9.00	70.00	Procladius.sp.
.003	-9.00	20.00	Cryptochironomus.sp.
.003	-9.00	43.00	Nais.variabilis
.003	-9.00	53.00	Piguetiella.michiganensis
.003	-9.00	58.00	Pisidium.henslowanum
.003	-9.00	78.00	Spirosperma.ferox
.003	-9.00	87.00	Uncinais.uncinata
.003	.01	90.00	Vejdovskyella.intermedia
.004	-9.00	23.00	Gammarus.fasciatus
.004	.01	54.00	Pisidium.casertanum
.004	-9.00	59.00	Pisidium.lilljeborgi
.004	-9.00	63.00	Polypedilum.scalaenum
.004	-9.00	76.00	Sphaerium.nitidum
.004	-9.00	82.00	Stylodrilus.heringianus
.004	.01	83.00	Tanytarsus.sp.
.005	-9.00	12.00	Chaetogaster.diaphanus
.005	-9.00	34.00	Limnodrilus.hoffmeisteri
.005	-9.00	56.00	Pisidium.conventus
.005	-9.00	61.00	Pisidium.variabile
.005	-9.00	67.00	Potamothrix.vejdovskyi
.005	-9.00	88.00	Valvata.sincera

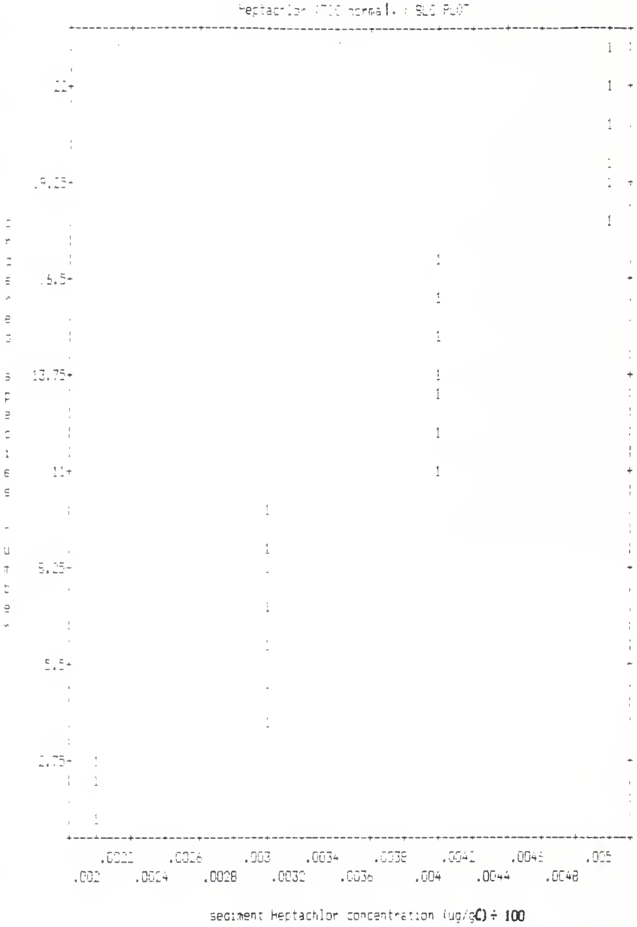

FIGURE C-11: SLC PLOT FOR HEPTACHLOR

TABLE C-12: TOC Neutralized Species SLC Values for Endrin ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.002	-9.00	96.00	Helobdella.stagnalis
.005	.02	35.00	Limnodrilus.sp.
.006	-9.00	8.00	Bithynia.tentaculata
.006	-9.00	46.00	Oecetis.sp.
.006	.03	85.00	Tubifex.sp.
.008	.03	70.00	Procladius.sp.
.019	-9.00	1.00	Ablabesmyia.sp.
.024	.06	14.00	Chironomus.sp.
.035	-9.00	39.00	Microtendipes.sp.
.046	-9.00	89.00	Valvata.tricarinata
.049	.06	20.00	Cryptochironomus.sp.
.049	-9.00	50.00	Phaenopsectra.sp.
.051	-9.00	3.00	Amnicola.limosa
.051	-9.00	75.00	Specaria.josinae
.057	.14	23.00	Gammarus.fasciatus
.059	.27	64.00	Polypedilum.sp.
.069	-9.00	78.00	Spirosperma.ferox
.080	-9.00	4.00	Asellus.sp.
.119	-9.00	71.00	Prostoma.rubrum
.140	-9.00	38.00	Manayunkia.speciosa
.190	-9.00	82.00	Stylodrilus.heringianus
.206	-9.00	83.00	Tanytarsus.sp.
.240	.35	54.00	Pisidium.casertanum
.262	-9.00	43.00	Nais.variabilis
.304	-9.00	13.00	Cheumatopsyche.sp.
.314	-9.00	62.00	Pleurocera.acuta
.342	-9.00	86.00	Turbellaria.sp.indet

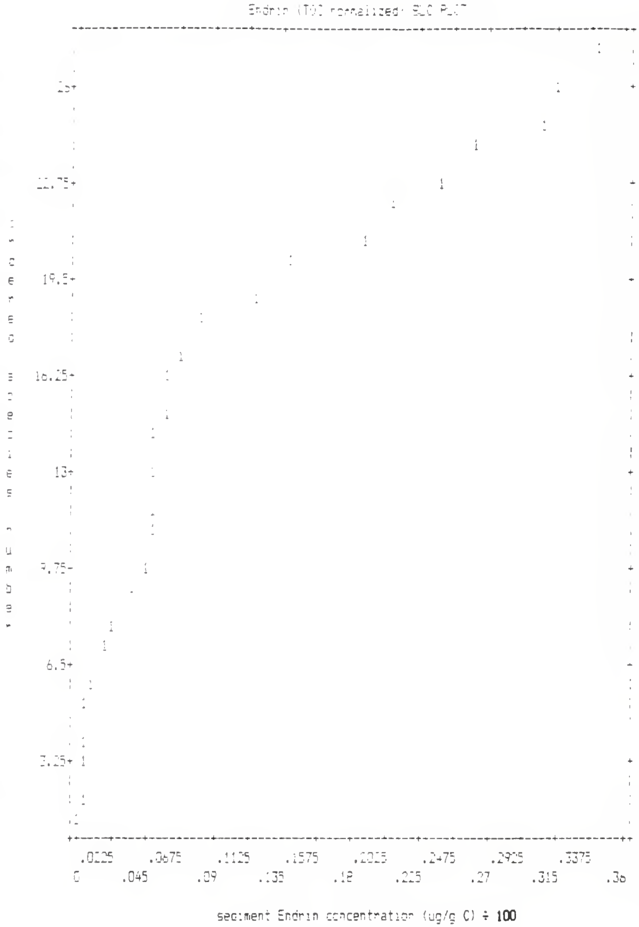

FIGURE C-12: SLC PLOT FOR ENDRIN

TABLE C-13: TOC Normalized Species SLC Values for
Mirex ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.00	-9.00	96.00	Helobdella.stagnalis
.01	-9.00	39.00	Microtendipes.sp.
.01	-9.00	76.00	Sphaerium.nitidum
.01	-9.00	58.00	Pisidium.henslowanum
.01	-9.00	60.00	Pisidium.nitidum
.01	.01	65.00	Pontoporeia.hoyi
.01	-9.00	66.00	Potamothrix.moldaviensis
.01	-9.00	52.00	Physella.gyrina
.01	-9.00	87.00	Uncinais.uncinata
.01	.04	90.00	Vejdovskyella.intermedia
.02	-9.00	56.00	Pisidium.conventus
.02	-9.00	63.00	Polypedilum.scalaenum
.02	.08	67.00	Potamothrix.vejdovskyi
.02	.03	35.00	Limnodrilus.sp.
.03	-9.00	61.00	Pisidium.variabile
.03	-9.00	46.00	Oecetis.sp.
.03	.09	85.00	Tubifex.sp.
.03	-9.00	8.00	Bithynia.tentaculata
.03	.04	82.00	Stylodrilus.heringianus
.03	.36	53.00	Piguetiella.michiganensis
.03	.23	70.00	Procladius.sp.
.04	.15	54.00	Pisidium.casertanum
.05	.78	18.00	Cricotopus.sp.
.05	-9.00	59.00	Pisidium.lilljeborgi
.05	.29	78.00	Spirosperma.ferox
.07	.92	20.00	Cryptochironomus.sp.
.07	-9.00	50.00	Phaenopsectra.sp.
.07	.85	14.00	Chironomus.sp.
.08	-9.00	38.00	Manayunkia.speciosa
.08	.54	64.00	Polypedilum.sp.
.09	-9.00	4.00	Asellus.sp.
.09	-9.00	30.00	Hyalella.azteca
.12	.51	23.00	Gammarus.fasciatus
.12	-9.00	12.00	Chaetogaster.diaphanus
.28	1.04	83.00	Tanytarsus.sp.
.30	.48	71.00	Prostoma.rubrum
.39	-9.00	1.00	Ablabesmyia.sp.
.39	-9.00	88.00	Valvata.sincera
.40	-9.00	84.00	Thienemannimyia.sp.
.41	.69	43.00	Nais.variabilis
.42	.79	89.00	Valvata.tricarinata
.48	-9.00	7.00	Aulodrilus.pleuriseta
.49	1.13	34.00	Limnodrilus.hoffmeisteri
.66	-9.00	3.00	Amnicola.limosa
.72	-9.00	21.00	Dicrotendipes.sp.
.79	1.42	81.00	Stylaria.lacustris
.97	-9.00	75.00	Specaria.josinae
1.26	-9.00	47.00	Parachironomus.sp.
1.26	-9.00	74.00	Slavina.appendiculata
1.32	-9.00	6.00	Aulodrilus.piqueti
1.32	-9.00	13.00	Cheumatopsycne.sp.

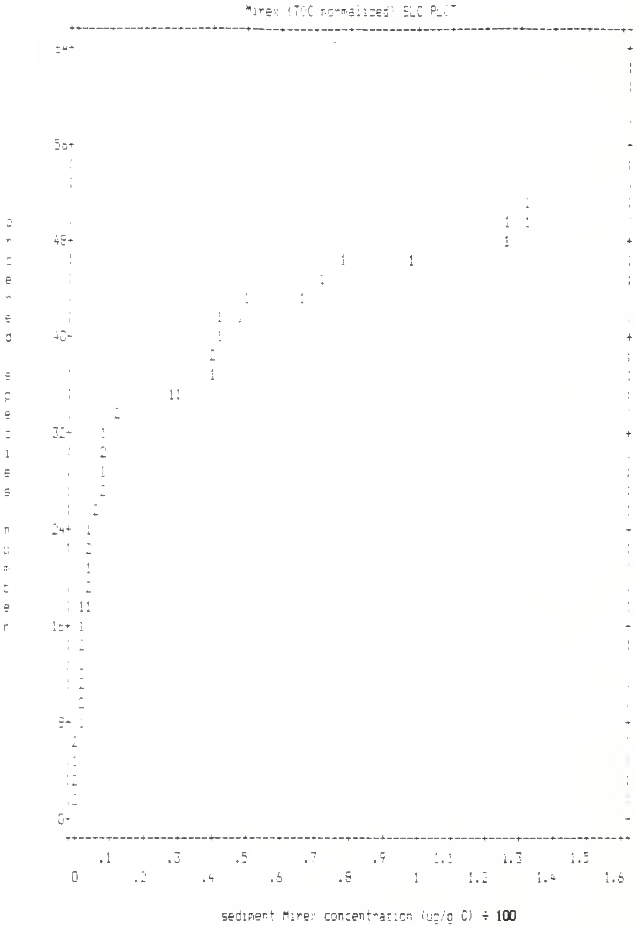

FIGURE C-13: SLC PLOT FOR MIREX

TABLE C-14: TOC Normalized Species SLC Values for Aldrin ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.002	.00	54.00	Pisidium.casertanum
.002	-9.00	58.00	Pisidium.henslowanum
.002	.00	65.00	Pontoporeia.hoyi
.002	-9.00	66.00	Potamothrix.moldaviensis
.002	-9.00	76.00	Sphaerium.nitidum
.002	-9.00	78.00	Spirosperma.ferox
.002	-9.00	88.00	Valvata.sincera
.003	-9.00	34.00	Limnodrilus.hoffmeisteri
.003	-9.00	43.00	Nais.variabilis
.003	-9.00	53.00	Piguetiella.michiganensis
.003	-9.00	60.00	Pisidium.nitidum
.003	-9.00	61.00	Pisidium.variabile
.003	-9.00	67.00	Potamothrix.vejdovskyi
.003	.00	83.00	Tanytarsus.sp.
.003	-9.00	87.00	Uncinais.uncinata
.003	.00	90.00	Vejdovskyella.intermedia
.004	-9.00	12.00	Chaetogaster.diaphanus
.004	-9.00	56.00	Pisidium.conventus
.004	-9.00	63.00	Polypedilum.scalaenum
.005	-9.00	8.00	Bithynia.tentaculata
.005	.01	20.00	Cryptochironomus.sp.
.005	-9.00	39.00	Microtendipes.sp.
.005	-9.00	46.00	Oecetis.sp.
.007	-9.00	96.00	Helobdella.stagnalis
.008	-9.00	1.00	Ablabesmyia.sp.
.009	.02	64.00	Polypedilum.sp.
.011	-9.00	82.00	Stylodrilus.heringianus
.019	.03	70.00	Procladius.sp.
.020	.03	23.00	Gammarus.fasciatus
.021	-9.00	59.00	Pisidium.lilljeborgi
.022	.03	35.00	Limnodrilus.sp.
.023	.17	14.00	Chironomus.sp.
.029	.09	85.00	Tubifex.sp.
.042	-9.00	89.00	Valvata.tricarinata
.047	-9.00	4.00	Asellus.sp.
.091	-9.00	18.00	Cricotopus.sp.
.091	-9.00	30.00	Hyalella.azteca

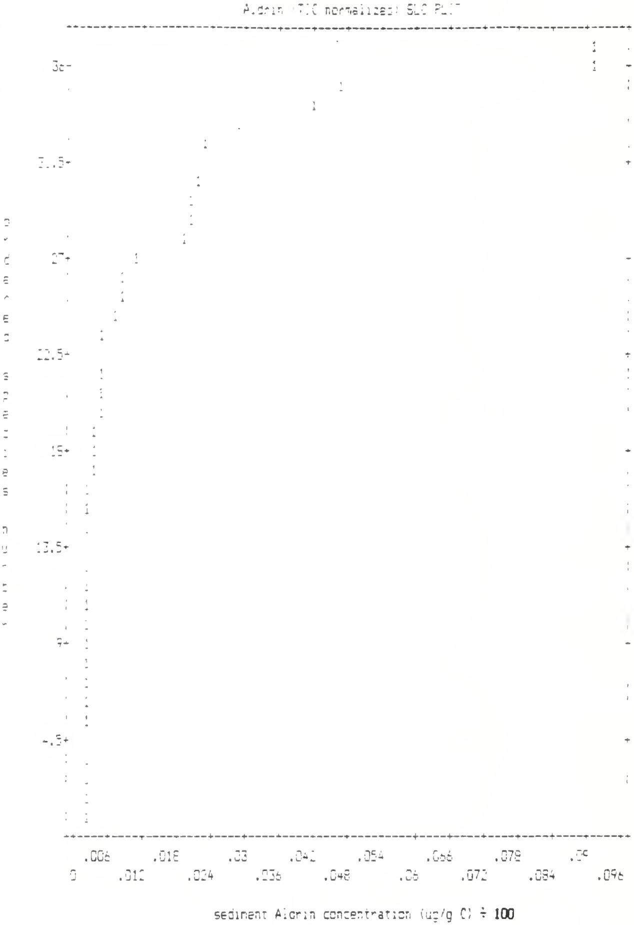

FIGURE C-14: SLC PLOT FOR ALDRIN

TABLE C-15: TOC Normalized Species SLC Values for Chlordane ((ng/g C)÷100)

P90	P95	SPNO	SPECIES
5.40	-9.00	46.00	Oecetis.sp.
7.21	15.36	50.00	Phaenopsectra.sp.
7.75	15.41	38.00	Manayunkia.speciosa
8.17	-9.00	10.00	Caenis.sp.
9.04	-9.00	77.00	Sphaerium.striatium
9.18	-9.00	67.00	Potamothrix.vejdovskyi
9.38	15.65	64.00	Polypedilum.sp.
10.77	15.48	1.00	Ablabesmyia.sp.
11.47	13.26	6.00	Aulodrilus.piqueti
12.58	15.43	34.00	Limnodrilus.hoffmeisteri
12.58	52.68	81.00	Stylaria.lacustris
12.88	15.08	74.00	Slavina.appendiculata
13.01	17.68	54.00	Pisidium.casertanum
13.18	-9.00	21.00	Dicrotendipes.sp.
13.33	40.96	89.00	Valvata.tricarinata
13.58	-9.00	88.00	Valvata.sincera
13.74	-9.00	39.00	Microtendipes.sp.
14.01	-9.00	8.00	Bithynia.tentaculata
14.07	16.01	75.00	Specaria.josinae
14.77	35.26	71.00	Prostoma.rubrum
14.81	16.06	3.00	Amnicola.limosa
15.18	40.83	43.00	Nais.variabilis
15.39	20.78	78.00	Spirosperma.ferox
15.47	49.17	12.00	Chaetogaster.diaphanus
15.51	-9.00	84.00	Thienemannimyia.sp.
15.55	54.74	62.00	Pleurocera.acuta
15.63	-9.00	44.00	Nanocladius.sp.
15.71	-9.00	45.00	Neureclipsis.sp.
15.79	-9.00	11.00	Ceraclea.sp.
15.79	-9.00	53.00	Piguetiella.michiganensis
15.89	-9.00	20.00	Cryptochironomus.sp.
15.89	22.85	83.00	Tanytarsus.sp.
17.06	53.16	82.00	Stylodrilus.heringianus
18.81	26.99	70.00	Procladius.sp.
19.59	32.63	23.00	Gammarus.fasciatus
21.35	-9.00	52.00	Physella.gyrina
22.82	67.71	13.00	Cheumatopsyche.sp.
23.99	33.88	35.00	Limnodrilus.sp.
25.44	-9.00	65.00	Pontoporeia.hoyi
25.44	-9.00	76.00	Sphaerium.nitidum
26.59	-9.00	79.00	Stenonema.sp.
32.48	-9.00	22.00	Eukiefferiella.sp.
33.52	244.47	85.00	Tubifex.sp.
53.17	-9.00	4.00	Asellus.sp.
53.25	-9.00	18.00	Cricotopus.sp.
54.62	-9.00	25.00	Glossosoma.sp.
57.66	-9.00	30.00	Hyalella.azteca
65.86	-9.00	31.00	Hydropsyche.sp.
65.86	-9.00	86.00	Turbellaria.sp.indet

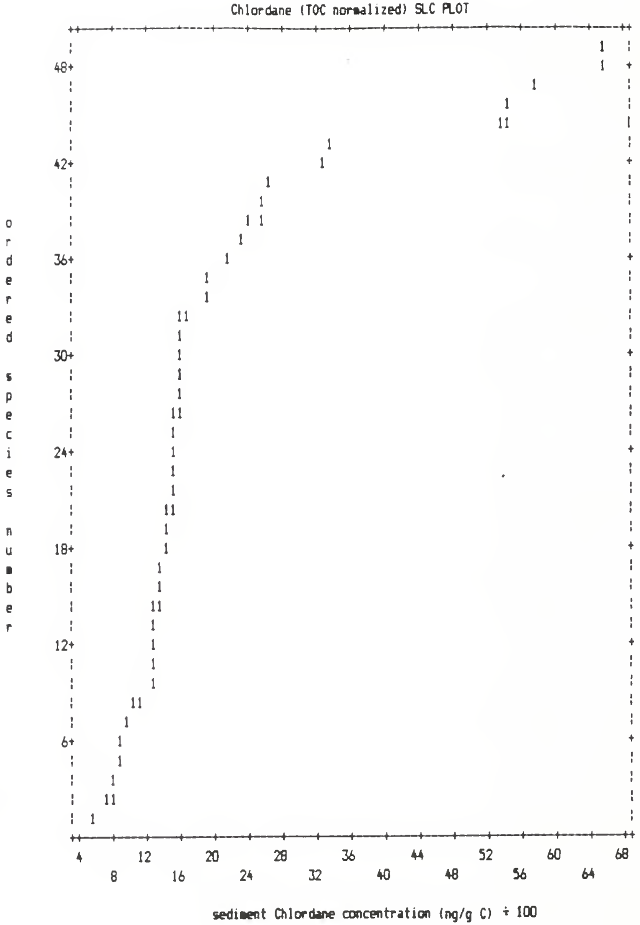

FIGURE C-15: SLC PLOT FOR CHLORDANE

TABLE C-16: TOC Normalized Species SLC Values for
ppDDT ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.01	-9.00	34.00	Limnodrilus.hoffmeisteri
.01	-9.00	83.00	Tanytarsus.sp.
.01	-9.00	3.00	Amnicola.limosa
.01	-9.00	43.00	Nais.variabilis
.01	-9.00	54.00	Pisidium.casertanum
.01	-9.00	71.00	Prostoma.rubrum
.01	-9.00	75.00	Specaria.josinae
.01	-9.00	78.00	Spirosperma.ferox
.01	-9.00	8.00	Bithynia.tentaculata
.01	-9.00	39.00	Microtendipes.sp.
.01	-9.00	96.00	Helobdella.stagnalis
.01	-9.00	46.00	Oecetis.sp.
.02	-9.00	20.00	Cryptochironomus.sp.
.02	.02	64.00	Polypedilum.sp.
.02	-9.00	1.00	Ablabesmyia.sp.
.03	.10	14.00	Chironomus.sp.
.03	.08	23.00	Gammarus.fasciatus
.03	.03	70.00	Procladius.sp.
.03	.03	35.00	Limnodrilus.sp.
.03	.09	85.00	Tubifex.sp.
.04	-9.00	89.00	Valvata.tricarinata
.11	-9.00	4.00	Asellus.sp.
.11	-9.00	81.00	Stylaria.lacustris
.14	-9.00	18.00	Cricotopus.sp.
.14	-9.00	30.00	Hyalella.azteca

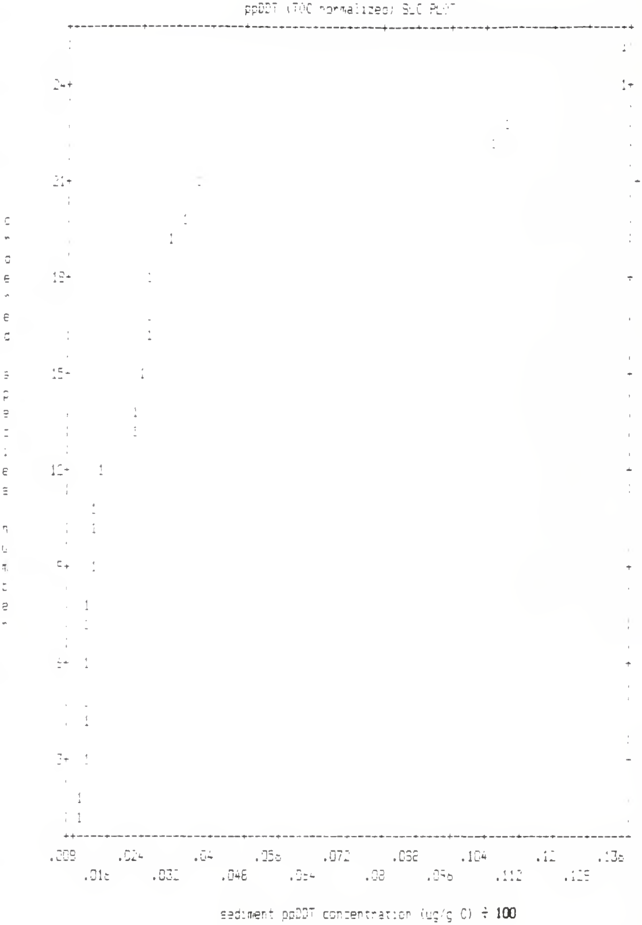

FIGURE C-16: SLC PLOT FOR p,p-DDT

TABLE C-17: TOC Normalized Species SLC Values for
ppDDD ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.01	-9.00	1.00	Ablabesmyia.sp.
.01	-9.00	34.00	Limnodrilus.hoffmeisteri
.01	-9.00	3.00	Amnicola.limosa
.01	-9.00	43.00	Nais.variabilis
.01	.01	64.00	Polypedilum.sp.
.01	-9.00	71.00	Prostoma.rubrum
.01	-9.00	75.00	Specaria.josinae
.01	-9.00	96.00	Helobdella.stagnalis
.01	-9.00	20.00	Cryptochironomus.sp.
.02	-9.00	8.00	Bithynia.tentaculata
.02	-9.00	39.00	Microtendipes.sp.
.02	-9.00	46.00	Oecetis.sp.
.02	.10	14.00	Chironomus.sp.
.02	.03	35.00	Limnodrilus.sp.
.02	.03	70.00	Procladius.sp.
.03	.10	23.00	Gammarus.fasciatus
.03	-9.00	89.00	Valvata.tricarinata
.03	.09	85.00	Tubifex.sp.
.05	-9.00	18.00	Cricotopus.sp.
.05	-9.00	4.00	Asellus.sp.
.06	-9.00	81.00	Stylaria.lacustris
.06	-9.00	30.00	Hyalella.azteca
.06	-9.00	54.00	Pisidium.casertanum
.09	-9.00	83.00	Tanytarsus.sp.
.09	-9.00	78.00	Spirosperma.ferox

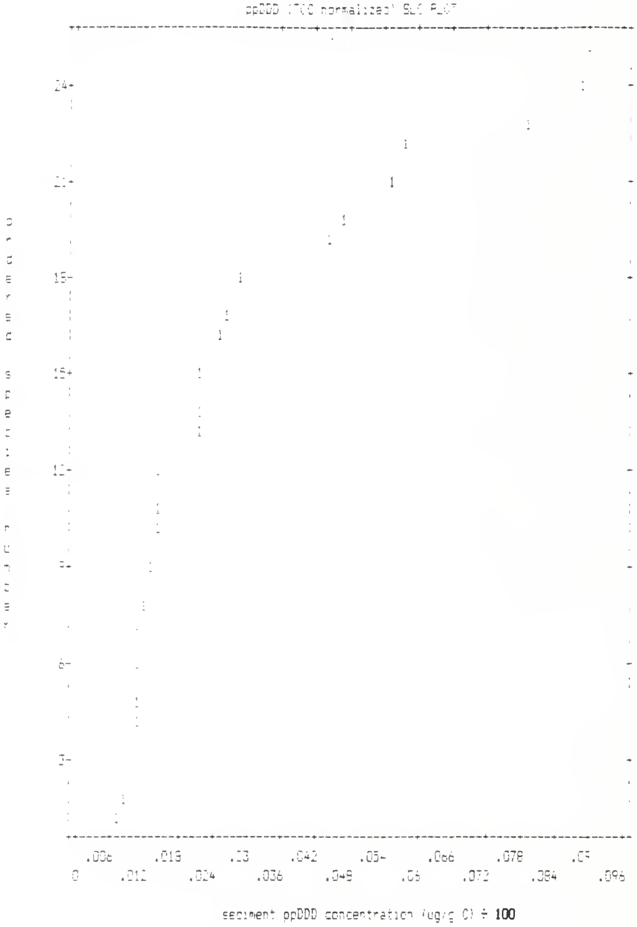

FIGURE C-17: SLC PLOT FOR p,p-DDD

TABLE C-18: TOC Normalized Species SLC Values for
ppDDE ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.01	-9.00	10.00	Caenis.sp.
.01	-9.00	39.00	Microtendipes.sp.
.01	-9.00	47.00	Parachironomus.sp.
.01	.34	53.00	Piguetiella.michiganensis
.01	-9.00	58.00	Pisidium.henslowanum
.01	-9.00	76.00	Sphaerium.nitidum
.01	.07	83.00	Tanytarsus.sp.
.01	.03	88.00	Valvata.sincera
.01	-9.00	89.00	Valvata.tricarinata
.01	.01	65.00	Pontoporeia.hoyi
.01	-9.00	74.00	Slavina.appendiculata
.01	-9.00	96.00	Helobdella.stagnalis
.01	-9.00	1.00	Ablabesmyia.sp.
.01	-9.00	46.00	Oecetis.sp.
.01	-9.00	61.00	Pisidium.variabile
.01	.02	82.00	Stylodrilus.heringianus
.01	.02	64.00	Polypedilum.sp.
.01	-9.00	56.00	Pisidium.conventus
.01	.29	66.00	Potamothrix.moldaviensis
.01	.16	34.00	Limnodrilus.hoffmeisteri
.02	.03	54.00	Pisidium.casertanum
.02	-9.00	8.00	Bithynia.tentaculata
.02	.07	20.00	Cryptochironomus.sp.
.02	-9.00	50.00	Phaenopsectra.sp.
.02	.03	70.00	Procladius.sp.
.02	-9.00	62.00	Pleurocera.acuta
.02	-9.00	77.00	Sphaerium.striatium
.02	.18	78.00	Spirosperma.ferox
.02	.05	90.00	Vejdovskyella.intermedia
.02	.03	14.00	Chironomus.sp.
.02	.03	35.00	Limnodrilus.sp.
.02	-9.00	75.00	Specaria.josinae
.02	-9.00	52.00	Physella.gyrina
.02	.23	67.00	Potamothrix.vejdovskyi
.02	-9.00	11.00	Ceraclea.sp.
.02	-9.00	22.00	Eukiefferiella.sp.
.02	.04	23.00	Gammarus.fasciatus
.02	.12	71.00	Prostoma.rubrum
.03	-9.00	3.00	Amnicola.limosa
.03	-9.00	13.00	Cheumatopsyche.sp.
.03	-9.00	86.00	Turbellaria.sp.Indet
.03	.38	12.00	Chaetogaster.diaphanus
.03	-9.00	6.00	Aulodrilus.piqueti
.03	-9.00	38.00	Manayunkia.speciosa
.03	.23	43.00	Nais.variabilis
.03	.09	85.00	Tubifex.sp.
.03	-9.00	63.00	Polypedilum.scalaenum
.04	-9.00	84.00	Thienemannimyia.sp.
.04	-9.00	49.00	Paratendipes.sp.
.04	-9.00	59.00	Pisidium.lilljeborgi
.05	-9.00	79.00	Stenonema.sp.
.05	.13	81.00	Stylaria.lacustris
.05	-9.00	87.00	Uncinais.uncinata
.07	.09	18.00	Cricotopus.sp.
.07	-9.00	4.00	Asellus.sp.
.10	-9.00	57.00	Pisidium.fallax
.11	-9.00	30.00	Hyalella.azteca
.20	-9.00	60.00	Pisidium.nitidum
.21	-9.00	7.00	Aulodrilus.pleuriseta
.25	-9.00	42.00	Nais.communis
.28	-9.00	29.00	Heterotrissocladius.sp.

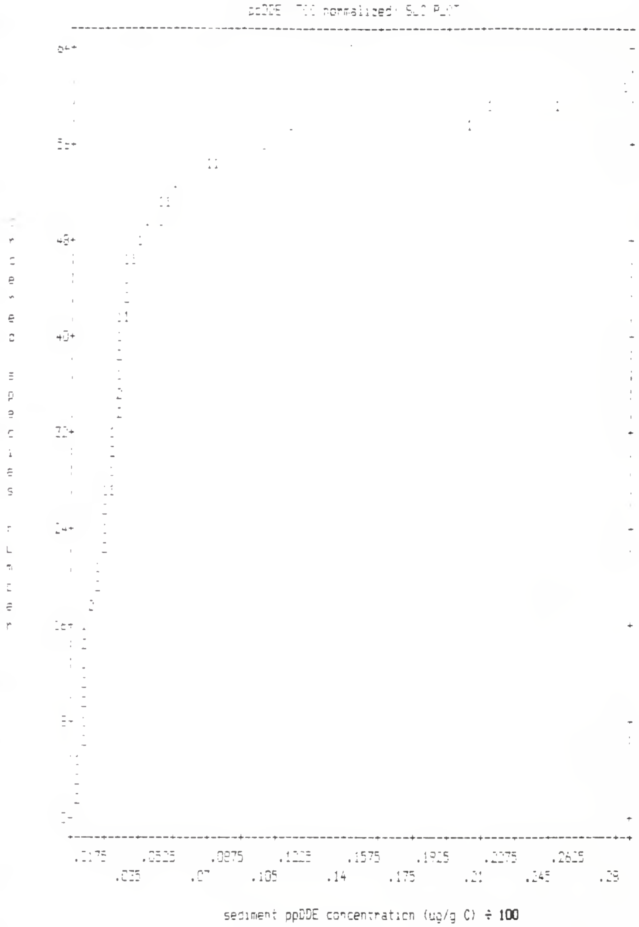

FIGURE C-18: SLC PLOT FOR p,p-DDE

TABLE C-19: TOC Normalized Species SLC Values for opDDT ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.01	-9.00	39.00	Microtendipes.sp.
.01	-9.00	96.00	Helobdella.stagnalis
.01	-9.00	83.00	Tanytarsus.sp.
.01	-9.00	20.00	Cryptochironomus.sp.
.01	-9.00	8.00	Bithynia.tentaculata
.01	-9.00	46.00	Oecetis.sp.
.01	-9.00	54.00	Pisidium.casertanum
.01	-9.00	78.00	Spirosperma.ferox
.01	-9.00	50.00	Phaenopsectra.sp.
.02	.02	64.00	Polypedilum.sp.
.02	-9.00	1.00	Ablabesmyia.sp.
.02	-9.00	82.00	Stylodrilus.heringianus
.02	.03	23.00	Gammarus.fasciatus
.02	.03	70.00	Procladius.sp.
.02	.10	14.00	Chironomus.sp.
.02	.03	35.00	Limnodrilus.sp.
.03	.09	85.00	Tubifex.sp.
.04	-9.00	89.00	Valvata.tricarinata
.07	-9.00	4.00	Asellus.sp.
.09	-9.00	18.00	Cricotopus.sp.
.12	-9.00	30.00	Hyalella.azteca

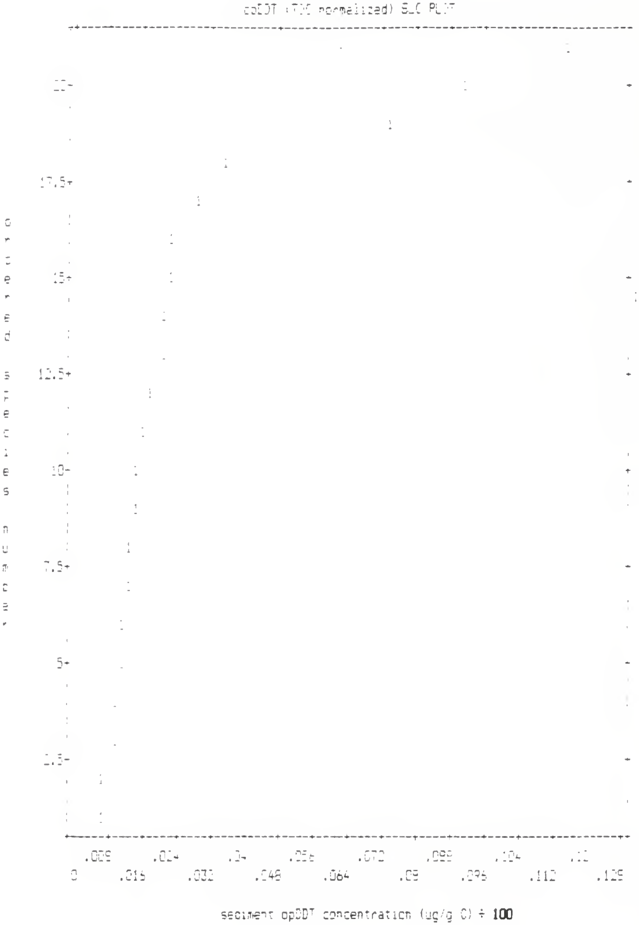

FIGURE C-19: SLC PLOT FOR o,p-DDT

TABLE C-20: TOC Normalized Species SLC Values for
PCB 1254 ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.06	-9.00	30.00	Hyalella.azteca
.06	-9.00	39.00	Microtendipes.sp.
.07	-9.00	96.00	Helobdella.stagnalis
.07	-9.00	46.00	Oecetis.sp.
.09	-9.00	20.00	Cryptochironomus.sp.
.21	.27	64.00	Polypedilum.sp.
.26	.38	14.00	Chironomus.sp.
.31	-9.00	18.00	Cricotopus.sp.
.32	-9.00	4.00	Asellus.sp.
.32	.38	35.00	Limnodrilus.sp.
.33	.37	70.00	Procladius.sp.
.33	.38	23.00	Gammarus.fasciatus
.35	.49	85.00	Tubifex.sp.

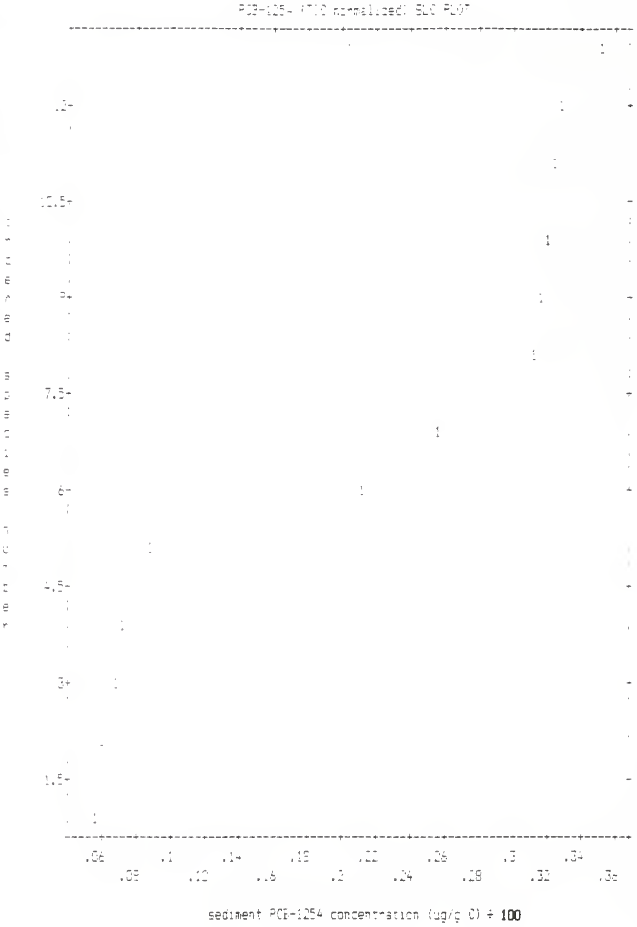

FIGURE C-20: SLC PLOT FOR PCB 1254

TABLE C-21: TOC Normalized Species SLC Values for PCB 1248 ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.03	.04	64.00	Polypedilum.sp.
.05	-9.00	20.00	Cryptochironomus.sp.
.05	-9.00	96.00	Helobdella.stagnalis
.06	-9.00	30.00	Hyalella.azteca
.06	-9.00	46.00	Oecetis.sp.
.06	-9.00	4.00	Asellus.sp.
.06	-9.00	39.00	Microtendipes.sp.
.06	.67	14.00	Chironomus.sp.
.10	.73	23.00	Gammarus.fasciatus
.28	1.07	35.00	Limnodrilus.sp.
.58	1.14	70.00	Procladius.sp.
1.03	1.36	85.00	Tubifex.sp.
1.82	-9.00	18.00	Cricotopus.sp.

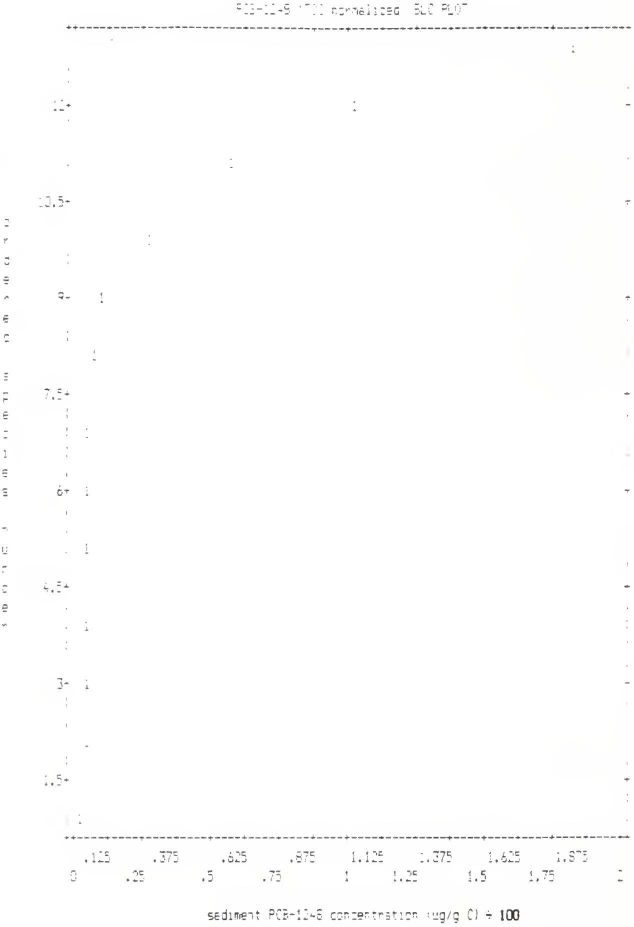

FIGURE C-21: SLC PLOT FOR PCB 1248

TABLE C-22: TOC Normalized Species SLC Values for PCB 1016 ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.01	-9.00	39.00	Microtendipes.sp.
.01	-9.00	46.00	Oecetis.sp.
.03	-9.00	20.00	Cryptochironomus.sp.
.06	.42	14.00	Chironomus.sp.
.06	-9.00	96.00	Helobdella.stagnalis
.09	.43	23.00	Gammarus.fasciatus
.25	.27	64.00	Polypedilum.sp.
.26	-9.00	18.00	Cricotopus.sp.
.26	.39	35.00	Limnodrilus.sp.
.27	.42	70.00	Procladius.sp.
.35	.48	85.00	Tubifex.sp.
.45	-9.00	4.00	Asellus.sp.
.59	-9.00	30.00	Hyalella.azteca

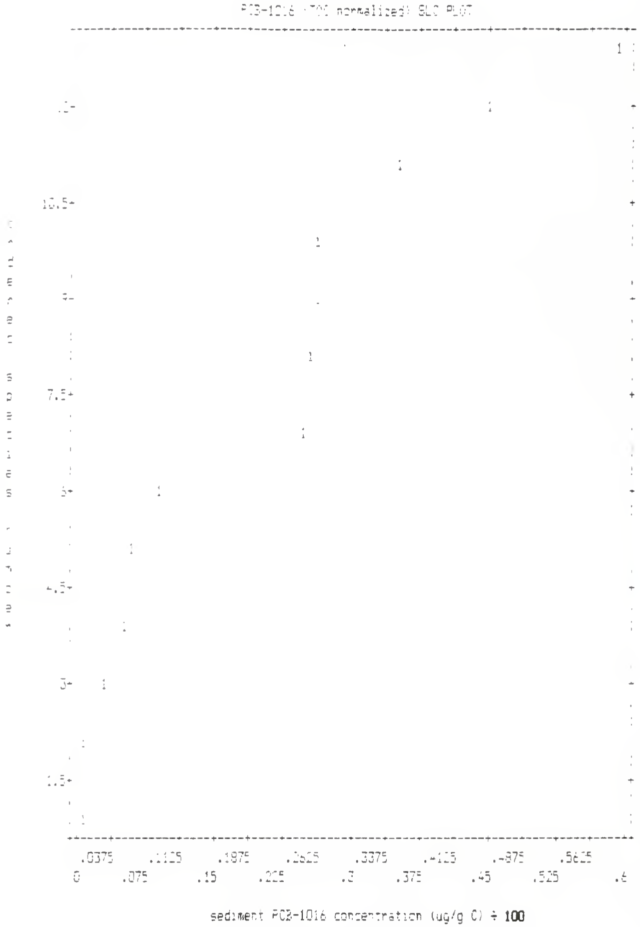

FIGURE C-22: SLC PLOT FOR PCB 1016

TABLE C-23: TOC Normalized Species SLC Values for PCBs ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.11	-9.00	96.00	Helobdella.stagnalis
.12	-9.00	39.00	Microtendipes.sp.
.15	.21	65.00	Pontoporeia.hoyi
.17	-9.00	63.00	Polypedilum.scalaenum
.17	-9.00	76.00	Sphaerium.nitidum
.20	-9.00	56.00	Pisidium.conventus
.21	-9.00	47.00	Parachironomus.sp.
.22	.32	58.00	Pisidium.henslowanum
.22	-9.00	28.00	Helisoma.anceps
.22	.96	90.00	Vejdovskyella.intermedia
.23	-9.00	61.00	Pisidium.variabile
.27	-9.00	10.00	Caenis.sp.
.27	.34	83.00	Tanytarsus.sp.
.27	-9.00	73.00	Quistadrilus.multisetosus
.31	.40	14.00	Chironomus.sp.
.31	-9.00	49.00	Paratendipes.sp.
.31	14.27	42.00	Nais.communis
.31	.34	74.00	Slavina.appendiculata
.32	.84	34.00	Limnodrilus.hoffmeisteri
.32	9.13	53.00	Piguetiella.michiganensis
.33	.75	81.00	Stylaria.lacustris
.34	2.58	67.00	Potamothrix.vejdovskyi
.35	-9.00	21.00	Dicrotendipes.sp.
.36	.84	20.00	Cryptochironomus.sp.
.36	.98	6.00	Aulodrilus.piqueti
.36	-9.00	36.00	Limnodrilus.udekemianus
.36	7.10	66.00	Potamothrix.moldaviensis
.37	.78	89.00	Valvata.tricarinata
.38	-9.00	8.00	Bithynia.tentaculata
.38	14.27	87.00	Uncinais.uncinata
.39	.43	52.00	Physella.gyrina
.40	.91	3.00	Amnicola.limosa
.42	2.77	54.00	Pisidium.casertanum
.42	6.72	43.00	Nais.variabilis
.42	1.26	82.00	Stylodrilus.heringianus
.43	2.07	23.00	Gammarus.fasciatus
.43	7.15	57.00	Pisidium.fallax
.43	-9.00	59.00	Pisidium.lilljeborgi
.46	-9.00	33.00	Ilyodrilus.templetoni
.47	1.01	75.00	Specaria.josinae
.49	-9.00	32.00	Hydroptila.sp.
.52	-9.00	30.00	Hyalella.azteca
.54	2.35	78.00	Spirosperma.ferox
.56	.58	1.00	Ablabesmyia.sp.
.57	1.53	64.00	Polypedilum.sp.
.57	1.33	70.00	Procladius.sp.
.60	10.09	88.00	Valvata.sincera
.62	2.08	18.00	Cricotopus.sp.
.63	2.02	35.00	Limnodrilus.sp.
.67	-9.00	84.00	Thienemannimyia.sp.
.67	1.12	50.00	Phaenopsectra.sp.
.67	.98	46.00	Oecetis.sp.
.70	-9.00	4.00	Asellus.sp.
.72	-9.00	16.00	Cladotanytarsus.sp.
.77	8.96	38.00	Manayunkia.speciosa
.87	-9.00	15.00	Cladopelma.sp.
1.04	13.62	7.00	Aulodrilus.pleuriseta
1.07	7.60	86.00	Turbellaria.sp.indet
1.11	10.57	71.00	Prostoma.rubrum
1.36	9.53	12.00	Chaetogaster.diaphanus
1.84	5.59	85.00	Tubifex.sp.
1.86	19.48	13.00	Cheumatopsyche.sp.
3.26	-9.00	60.00	Pisidium.nitidum
6.34	23.02	62.00	Pleurocera.acuta
6.43	-9.00	5.00	Aulodrilus.limnobius
6.59	-9.00	69.00	Pristina.osborni
7.60	-9.00	11.00	Ceraclea.sp.
9.98	-9.00	22.00	Eukiefferiella.sp.
10.57	-9.00	29.00	Heterotrissocladius.sp.
10.86	-9.00	48.00	Paralauterborniella.sp.
11.36	-9.00	79.00	Stenonema.sp.
12.35	-9.00	44.00	Nanocladius.sp.
21.48	-9.00	25.00	Glossosoma.sp.

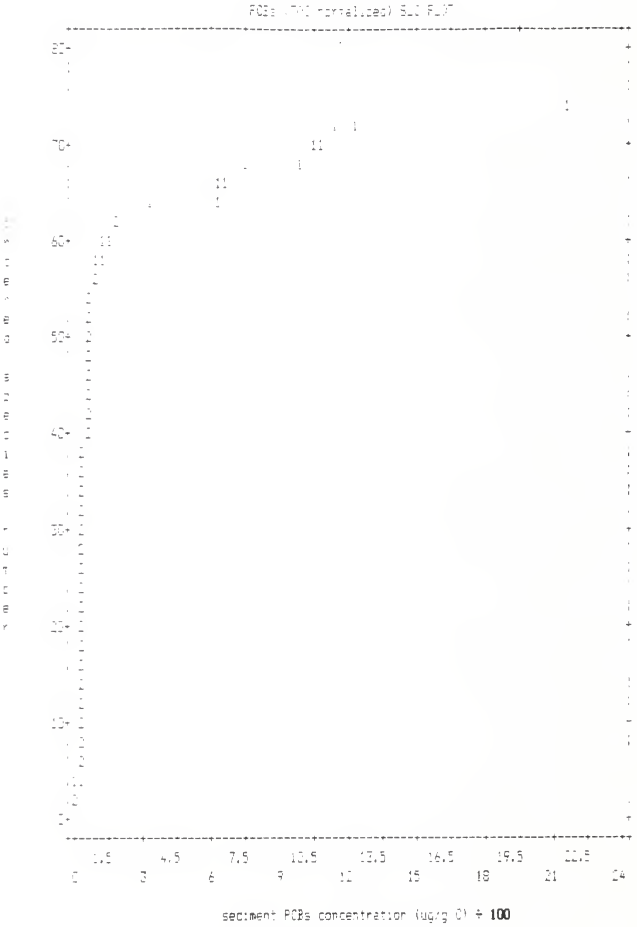

FIGURE C-23: SLC PLOT FOR PCB

TABLE C-24: TOC Normalized Species SLC Values for
Dieldrin ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.003	-9.00	96.00	Helobdella.stagnalis
.006	.02	35.00	Limnodrilus.sp.
.013	.54	85.00	Tubifex.sp.
.023	-9.00	39.00	Microtendipes.sp.
.028	-9.00	4.00	Asellus.sp.
.034	.05	88.00	Valvata.sincera
.035	-9.00	27.00	Gyraulus.parvus
.035	.04	70.00	Procladius.sp.
.036	-9.00	21.00	Dicrotendipes.sp.
.036	-9.00	36.00	Limnodrilus.udekemianus
.040	.09	64.00	Polypedilum.sp.
.040	.06	75.00	Specaria.josinae
.041	-9.00	49.00	Paratendipes.sp.
.043	.07	14.00	Chironomus.sp.
.044	.17	10.00	Caenis.sp.
.044	.08	20.00	Cryptochironomus.sp.
.044	.13	22.00	Eukiefferiella.sp.
.044	.11	43.00	Nais.variabilis
.044	.13	84.00	Thienemannimyia.sp.
.045	.18	52.00	Physella.gyrina
.046	.15	6.00	Aulodrilus.piqueti
.047	.08	32.00	Hydroptila.sp.
.053	.10	54.00	Pisidium.casertanum
.054	.15	1.00	Ablabesmyia.sp.
.054	.15	50.00	Phaenopsectra.sp.
.057	.13	23.00	Gammarus.fasciatus
.057	-9.00	33.00	Ilyodrilus.templetoni
.059	.13	81.00	Stylaria.lacustris
.063	-9.00	8.00	Bithynia.tentaculata
.063	.77	53.00	Piguetiella.michiganensis
.064	.11	89.00	Valvata.tricarinata
.066	-9.00	58.00	Pisidium.henslowanum
.076	.13	86.00	Turbellaria.sp.indet
.077	.13	11.00	Ceraclea.sp.
.077	.13	25.00	Glossosoma.sp.
.077	.44	34.00	Limnodrilus.hoffmeisteri
.078	.24	78.00	Spirosperma.ferox
.080	.17	16.00	Cladotanytarsus.sp.
.080	.12	45.00	Neureclipsis.sp.
.080	-9.00	51.00	Phallodrilus.sp.
.081	.13	13.00	Cheumatopsyche.sp.
.081	.20	77.00	Sphaerium.striatium
.084	-9.00	72.00	Pseudocleon.sp.
.086	-9.00	30.00	Hyalella.azteca
.086	.12	82.00	Stylodrilus.heringianus
.089	.18	46.00	Oecetis.sp.
.091	.13	62.00	Pleurocera.acuta
.092	.12	44.00	Nanocladius.sp.
.092	.19	57.00	Pisidium.fallax
.093	.20	3.00	Amnicola.limosa
.095	.14	71.00	Prostoma.rubrum
.095	.17	74.00	Slavina.appendiculata
.099	.24	38.00	Manayunkia.speciosa
.100	.73	67.00	Potamothrix.vejdovskyi
.107	.14	79.00	Stenonema.sp.
.112	.80	42.00	Nais.communis
.118	.13	31.00	Hydropsyche.sp.
.128	.13	41.00	Nais.behningi
.132	.17	37.00	Lumbriculus.variegatus
.132	.39	83.00	Tanytarsus.sp.
.133	.64	69.00	Pristina.osborni
.151	-9.00	15.00	Cladopelma.sp.
.167	1.26	18.00	Cricotopus.sp.
.292	-9.00	5.00	Aulodrilus.limnobius
.341	-9.00	66.00	Potamothrix.moldaviensis
.341	-9.00	90.00	Vejdovskyella.intermedia
.388	-9.00	12.00	Chaetogaster.diaphanus
.494	-9.00	7.00	Aulodrilus.pleuriseta
.734	-9.00	60.00	Pisidium.nitidum
.856	-9.00	48.00	Paralauterborniella.sp.
1.084	-9.00	68.00	Pristina.foreli

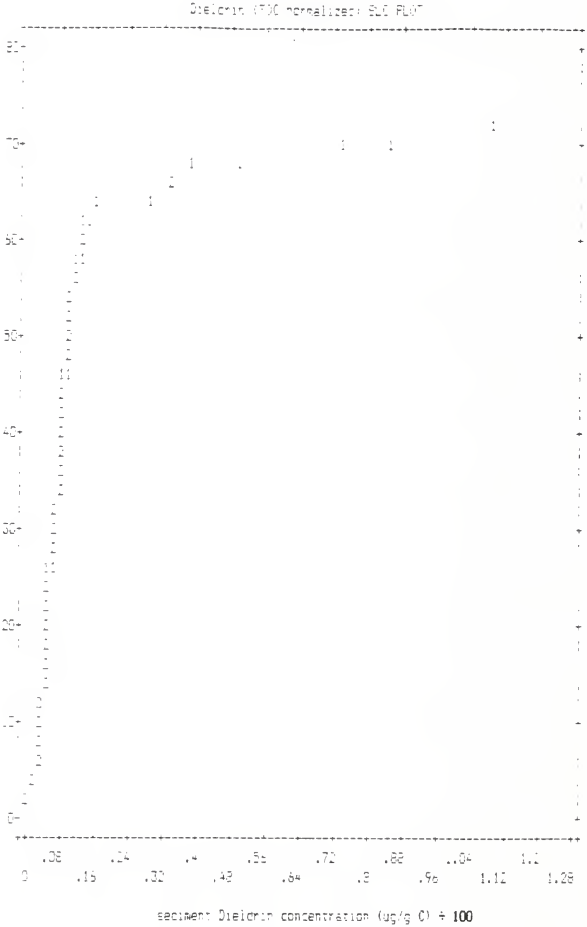

FIGURE C-24: SLC PLOT FOR DIELDRIN

TABLE C-25: TOC Normalized Species SLC Values for
BHC ((ng/g c)÷100)

P90	P95	SPNO	SPECIES
1.61	-9.00	61.00	Pisidium.variabile
2.22	-9.00	49.00	Paratendipes.sp.
3.17	-9.00	77.00	Sphaerium.striatium
3.70	4.96	67.00	Potamothrix.vejdovskyi
3.86	-9.00	90.00	Vejdovskyella.intermedia
4.41	4.98	50.00	Phaenopsectra.sp.
4.74	122.03	38.00	Manayunkia.speciosa
5.01	-9.00	8.00	Bithynia.tentaculata
5.16	-9.00	46.00	Oecetis.sp.
5.22	-9.00	39.00	Microtendipes.sp.
5.26	-9.00	79.00	Stenonema.sp.
5.26	13.46	82.00	Stylodrilus.heringianus
5.51	113.46	62.00	Pleurocera.acuta
5.62	16.79	54.00	Pisidium.casertanum
6.24	-9.00	22.00	Eukiefferiella.sp.
6.66	11.14	52.00	Physella.gyrina
6.72	-9.00	45.00	Neureclipsis.sp.
6.96	-9.00	25.00	Glossosoma.sp.
7.33	19.08	78.00	Spirosperma.ferox
8.43	40.00	64.00	Polypedilum.sp.
10.00	-9.00	65.00	Pontoporeia.hoyi
10.00	-9.00	76.00	Sphaerium.nitidum
10.29	-9.00	58.00	Pisidium.henslowanum
14.67	-9.00	84.00	Thienemannimyia.sp.
17.33	52.18	71.00	Prostoma.rubrum
21.33	68.54	89.00	Valvata.tricarinata
23.52	48.41	70.00	Procladius.sp.
23.99	33.88	35.00	Limnodrilus.sp.
25.88	72.17	3.00	Amnicola.limosa
30.67	161.97	13.00	Cheumatopsyche.sp.
30.92	116.46	11.00	Ceraclea.sp.
32.09	87.38	1.00	Ablabesmyia.sp.
33.52	244.47	85.00	Tubifex.sp.
33.61	187.69	14.00	Chironomus.sp.
33.61	117.43	23.00	Gammarus.fasciatus
36.55	-9.00	7.00	Aulodrilus.pleuriseta
38.67	131.12	83.00	Tanytarsus.sp.
40.12	-9.00	59.00	Pisidium.lilljeborgi
52.18	-9.00	5.00	Aulodrilus.limnobius
53.17	-9.00	4.00	Asellus.sp.
57.66	-9.00	30.00	Hyalella.azteca
59.58	187.69	20.00	Cryptochironomus.sp.
59.58	-9.00	44.00	Nanocladius.sp.
60.00	111.11	43.00	Nais.variabilis
60.00	111.11	75.00	Specaria.josinae
60.00	87.04	88.00	Valvata.sincera
60.53	-9.00	18.00	Cricotopus.sp.
60.89	94.26	53.00	Piguetiella.michiganensis
62.37	119.86	34.00	Limnodrilus.hoffmeisteri
64.05	156.83	81.00	Stylaria.lacustris
87.04	146.55	74.00	Slavina.appendiculata
91.85	151.69	6.00	Aulodrilus.piqueti
96.67	-9.00	36.00	Limnodrilus.udekemianus
112.08	-9.00	42.00	Nais.communis
114.03	-9.00	21.00	Dicrotendipes.sp.
115.00	-9.00	32.00	Hydroptila.sp.
116.94	-9.00	15.00	Cladopelma.sp.
116.94	203.11	86.00	Turbellaria.sp.indet
117.92	-9.00	57.00	Pisidium.fallax
131.12	-9.00	16.00	Cladotanytarsus.sp.
161.97	-9.00	10.00	Caenis.sp.

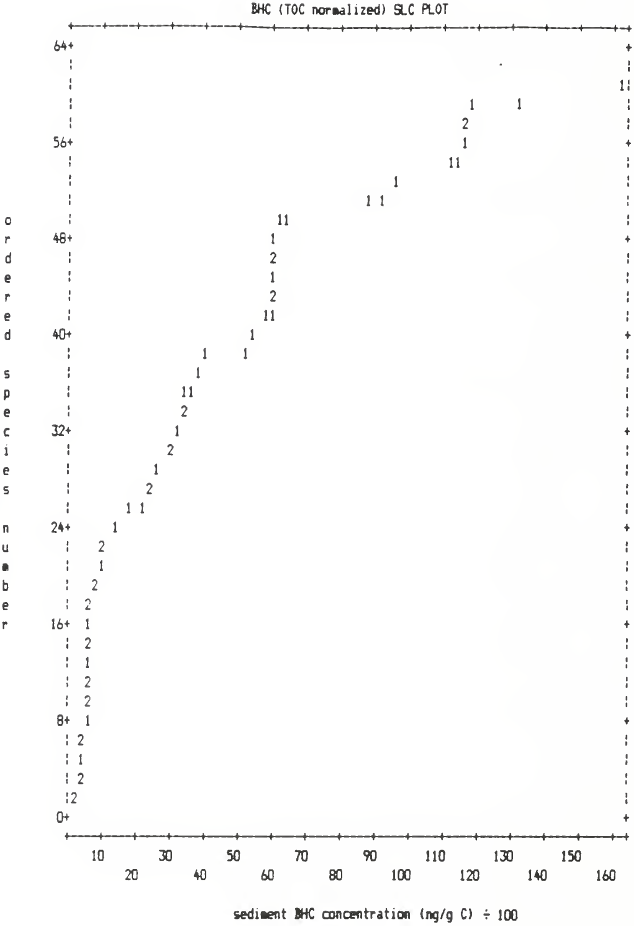

FIGURE C-25: SLC PLOT FOR BHC

TABLE C-26: TOC Normalized Species SLC Values for Lindane ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.003	-9.00	54.00	Pisidium.casertanum
.003	-9.00	75.00	Specaria.josinae
.003	-9.00	78.00	Spirosperma.ferox
.003	-9.00	96.00	Helobdella.stagnalis
.005	-9.00	8.00	Bithynia.tentaculata
.005	-9.00	39.00	Microtendipes.sp.
.005	-9.00	46.00	Oecetis.sp.
.007	-9.00	1.00	Ablabesmyia.sp.
.007	-9.00	83.00	Tanytarsus.sp.
.008	.01	64.00	Polypedilum.sp.
.009	-9.00	3.00	Amnicola.limosa
.009	-9.00	20.00	Cryptochironomus.sp.
.009	-9.00	34.00	Limnodrilus.hoffmeisteri
.009	-9.00	43.00	Nais.variabilis
.010	-9.00	71.00	Prostoma.rubrum
.019	.03	23.00	Gammarus.fasciatus
.020	.03	70.00	Procladius.sp.
.022	.10	14.00	Chironomus.sp.
.022	.03	35.00	Limnodrilus.sp.
.029	.09	85.00	Tubifex.sp.
.045	-9.00	18.00	Cricotopus.sp.
.073	-9.00	89.00	Valvata.tricarinata
.152	-9.00	4.00	Asellus.sp.
.216	-9.00	30.00	Hyalella.azteca
.265	-9.00	81.00	Stylaria.lacustris

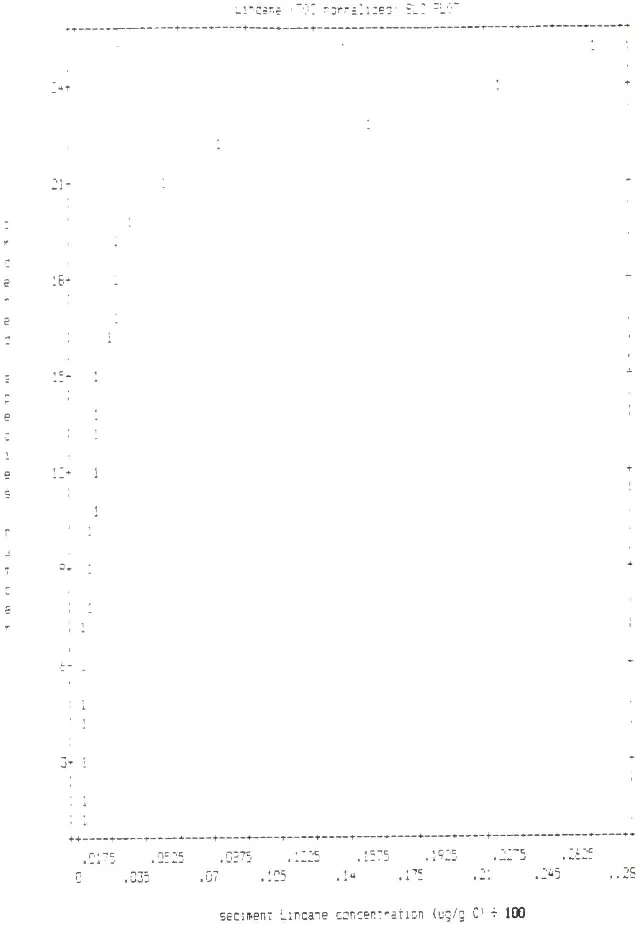

FIGURE C-26: SLC PLOT FOR γ-BHC

TABLE C-27: TOC Normalized Species SLC Values for
B-BHC ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.01	-9.00	39.00	Microtendipes.sp.
.01	-9.00	46.00	Oecetis.sp.
.02	.03	35.00	Limnodrilus.sp.
.03	.10	64.00	Polypedilum.sp.
.03	.06	70.00	Procladius.sp.
.03	.24	85.00	Tubifex.sp.
.04	-9.00	54.00	Pisidium.casertanum
.05	-9.00	78.00	Spirosperma.ferox
.05	-9.00	4.00	Asellus.sp.
.06	-9.00	71.00	Prostoma.rubrum
.06	-9.00	30.00	Hyalella.azteca
.06	.22	23.00	Gammarus.fasciatus
.08	-9.00	89.00	Valvata.tricarinata
.09	-9.00	18.00	Cricotopus.sp.
.10	.28	14.00	Chironomus.sp.
.10	-9.00	1.00	Ablabesmyia.sp.
.11	-9.00	43.00	Nais.variabilis
.12	-9.00	3.00	Amnicola.limosa
.17	-9.00	20.00	Cryptochironomus.sp.
.18	-9.00	75.00	Specaria.josinae
.18	-9.00	83.00	Tanytarsus.sp.
.19	-9.00	34.00	Limnodrilus.hoffmeisteri
.19	-9.00	81.00	Stylaria.lacustris
.20	-9.00	74.00	Slavina.appendiculata
.21	-9.00	6.00	Aulodrilus.piqueti

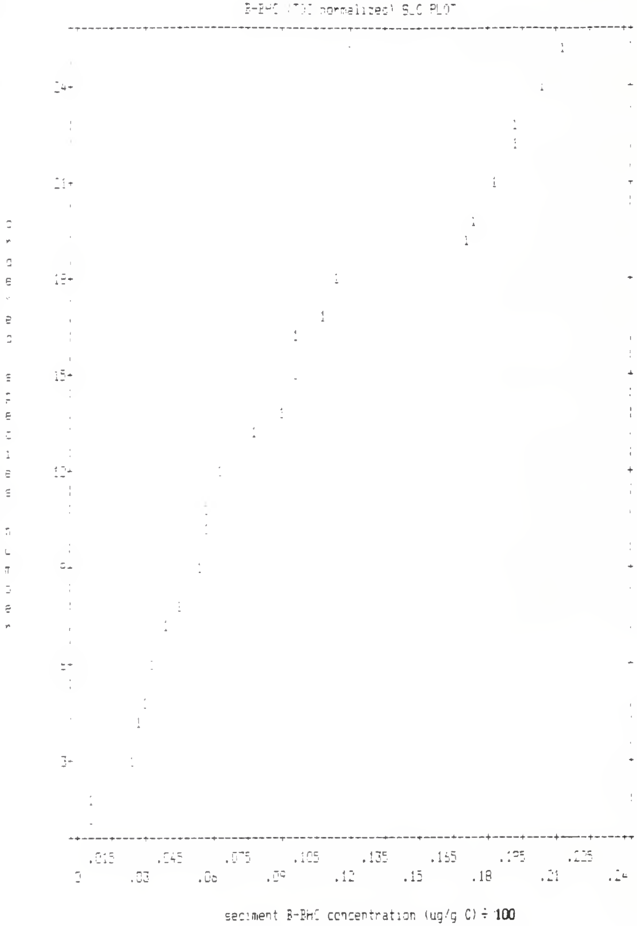

FIGURE C-27: SLC PLOT FOR β-BHC

TABLE C-28 TOC Normalized Species SLC Values for
A-BHC ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.01	-9.00	50.00	Phaenopsectra.sp.
.01	-9.00	82.00	Stylodrilus.heringianus
.01	.02	54.00	Pisidium.casertanum
.01	-9.00	78.00	Spirosperma.ferox
.02	.17	71.00	Prostoma.rubrum
.02	-9.00	64.00	Polypedilum.sp.
.02	-9.00	13.00	Cheumatopsyche.sp.
.03	-9.00	3.00	Amnicola.limosa
.03	-9.00	89.00	Valvata.tricarinata
.03	-9.00	83.00	Tanytarsus.sp.
.03	-9.00	81.00	Stylaria.lacustris
.03	-9.00	11.00	Ceraclea.sp.
.03	-9.00	20.00	Cryptochironomus.sp.
.03	.10	70.00	Procladius.sp.
.03	-9.00	1.00	Ablabesmyia.sp.
.03	.15	23.00	Gammarus.fasciatus
.03	-9.00	34.00	Limnodrilus.hoffmeisteri
.04	-9.00	75.00	Specaria.josinae
.04	-9.00	43.00	Nais.variabilis
.06	-9.00	6.00	Aulodrilus.piqueti
.07	-9.00	74.00	Slavina.appendiculata
.07	-9.00	86.00	Turbellaria.sp.indet
.08	-9.00	88.00	Valvata.sincera
.10	-9.00	53.00	Piguetiella.michiganensis
.10	-9.00	38.00	Manayunkia.speciosa
.10	-9.00	62.00	Pleurocera.acuta

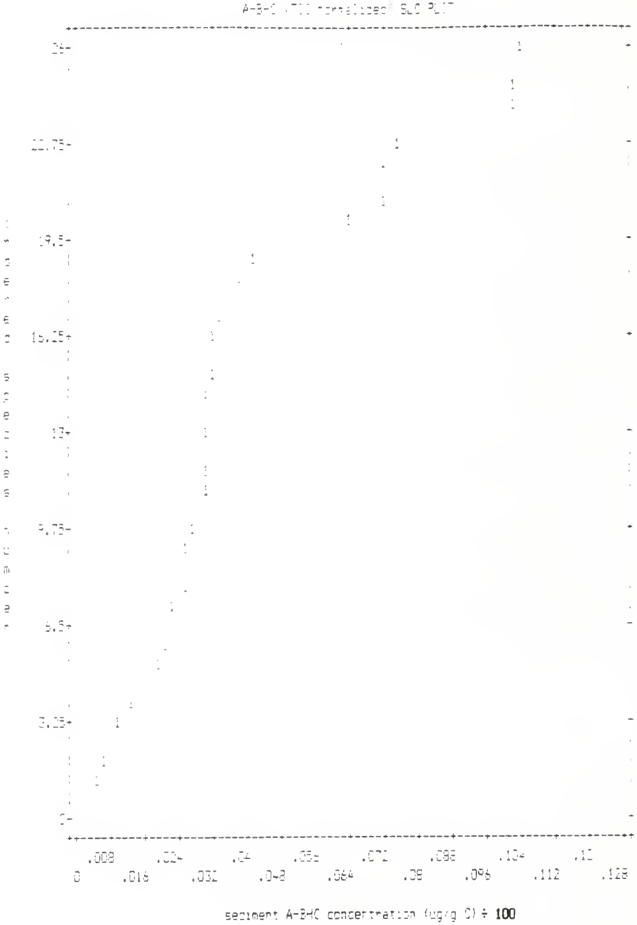

FIGURE C-28: SLC PLOT FOR α -BHC

TABLE C-29: TOC Normalized Species SLC Values for HCB ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.01	-9.00	39.00	Microtendipes.sp.
.01	.02	65.00	Pontoporeia.hoyi
.02	-9.00	96.00	Heloodella.stagnalis
.02	-9.00	27.00	Gyraulus.parvus
.02	-9.00	47.00	Parachironomus.sp.
.02	.02	61.00	Pisidium.variabile
.02	-9.00	10.00	Caenis.sp.
.02	.03	35.00	Limnodrilus.sp.
.03	.08	1.00	Ablabesmyia.sp.
.03	-9.00	28.00	Helisoma.anceps
.03	-9.00	56.00	Pisidium.conventus
.03	.03	58.00	Pisidium.henslowanum
.03	-9.00	55.00	Pisidium.compressum
.03	.04	64.00	Polypedilum.sp.
.03	-9.00	76.00	Sphaerium.nitidum
.03	.03	83.00	Tanytarsus.sp.
.03	.06	14.00	Chironomus.sp.
.03	1.19	42.00	Nais.communis
.03	.04	82.00	Stylodrilus.heringianus
.03	.09	85.00	Tubifex.sp.
.03	.04	70.00	Procladius.sp.
.03	-9.00	21.00	Dicrotendipes.sp.
.03	.04	54.00	Pisidium.casertanum
.03	.52	66.00	Potamothrix.moldaviensis
.03	.04	74.00	Slavina.appendiculata
.03	.05	90.00	Vejdovskyella.intermedia
.03	.11	20.00	Cryptochironomus.sp.
.04	.16	50.00	Phaenopsectra.sp.
.04	1.33	7.00	Aulodrilus.pleuriseta
.04	-9.00	49.00	Paratendipes.sp.
.04	.06	67.00	Potamothrix.vejdovskyi
.04	-9.00	79.00	Stenonema.sp.
.04	.05	52.00	Physella.gyrina
.04	.14	78.00	Spirosperma.ferox
.04	-9.00	36.00	Limnodrilus.udekemianus
.04	.38	62.00	Pleurocera.acuta
.04	.12	23.00	Gammarus.fasciatus
.04	-9.00	84.00	Thienemannimyia.sp.
.04	-9.00	77.00	Sphaerium.striatium
.04	.13	88.00	Valvata.sincera
.04	.13	3.00	Amnicola.limosa
.04	.14	34.00	Limnodrilus.hoffmeisteri
.05	.19	89.00	Valvata.tricarinata
.05	.09	43.00	Nais.variabilis
.05	-9.00	63.00	Polypedilum.scalaenum
.05	-9.00	22.00	Eukiefferiella.sp.
.05	-9.00	11.00	Ceraclea.sp.
.05	.48	57.00	Pisidium.fallax
.05	1.33	87.00	Uncinais.uncinata
.06	-9.00	16.00	Cladotanytarsus.sp.
.06	.16	18.00	Cricotopus.sp.
.06	-9.00	25.00	Glossosoma.sp.
.06	.17	46.00	Oecetis.sp.
.06	.73	53.00	Piguetiella.michiganensis
.06	-9.00	45.00	Neureclipsis.sp.
.06	.11	86.00	Turbellaria.sp.indet
.06	-9.00	8.00	Bithynia.tentaculata
.06	-9.00	37.00	Lumbriculus.variegatus
.06	.28	71.00	Prostoma.rubrum
.06	-9.00	32.00	Hydroptila.sp.
.07	.20	81.00	Stylaria.lacustris
.08	.16	6.00	Aulodrilus.piqueti
.08	.16	75.00	Specaria.josinae
.09	-9.00	44.00	Nanocladius.sp.
.09	.54	38.00	Manayunkia.speciosa
.09	.16	13.00	Cheumatopsyche.sp.
.10	-9.00	15.00	Cladopelma.sp.
.12	-9.00	59.00	Pisidium.lilljeborgi
.12	.91	12.00	Chaetogaster.diaphanus
.15	-9.00	33.00	Ilyodrilus.templetoni
.15	-9.00	4.00	Asellus.sp.
.25	-9.00	30.00	Hyalella.aazteca
.31	-9.00	60.00	Pisidium.nitidum
.46	-9.00	69.00	Pristina.osborni
.58	-9.00	29.00	Heterotrissocladius.sp.
.59	-9.00	48.00	Paralauterborniella.sp.
.67	-9.00	5.00	Aulodrilus.limnobius

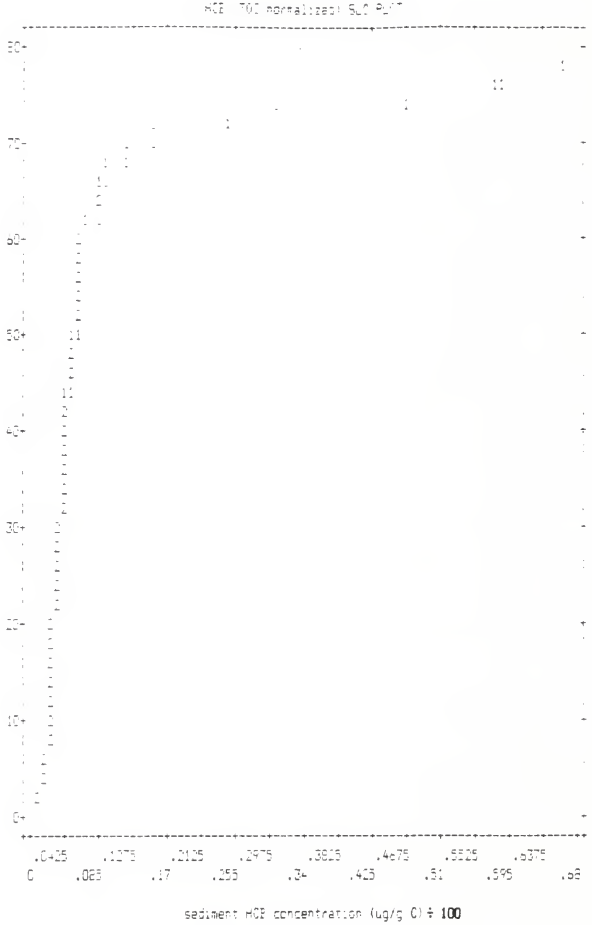

FIGURE C-29: SLC PLOT FOR HCB

TABLE C-30: TOC Normalized Species SLC Values for Heptachlor Epoxide ((ng/g C)÷100)

P90	P95	SPNO	SPECIES
3.36	-9.00	96.00	Helobdella.stagnalis
5.31	-9.00	8.00	Bithynia.tentaculata
5.31	-9.00	39.00	Microtendipes.sp.
5.40	-9.00	46.00	Oecetis.sp.
6.23	-9.00	20.00	Cryptochironomus.sp.
8.04	14.96	64.00	Polypedilum.sp.
21.66	30.28	70.00	Procladius.sp.
21.93	33.33	35.00	Limnodrilus.sp.
22.93	191.91	14.00	Chironomus.sp.
25.88	139.36	23.00	Gammarus.fasciatus
29.44	86.80	85.00	Tubifex.sp.
45.46	-9.00	18.00	Cricotopus.sp.
46.86	-9.00	4.00	Asellus.sp.
53.74	-9.00	89.00	Valvata.tricarinata
57.66	-9.00	30.00	Hyalella.azteca

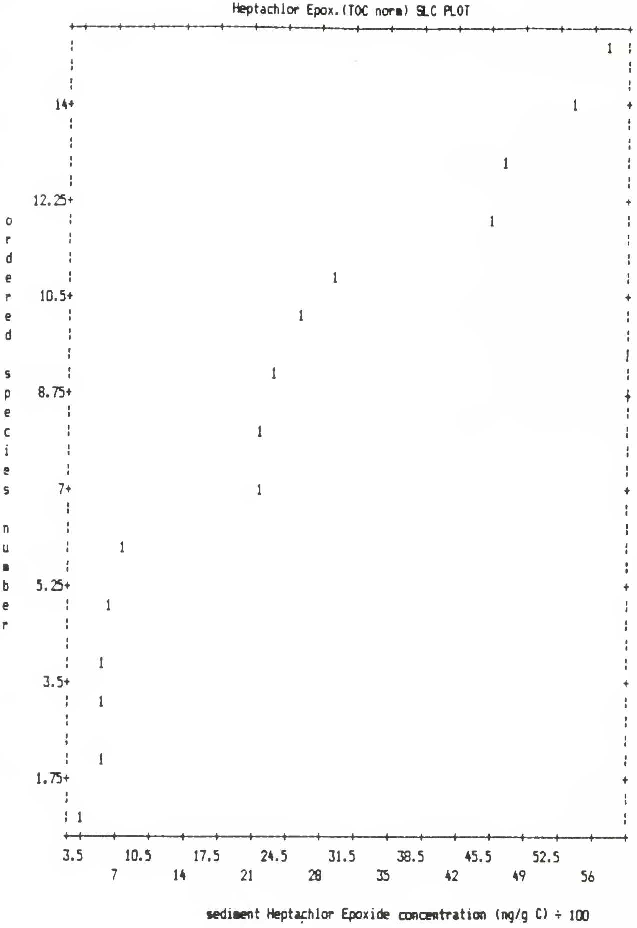

FIGURE C-30: SLC PLOT FOR HEPTACHLOR EPOXIDE

TABLE C-31: TOC Normalized Species SLC Values for
G-Chlordane ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.01	-9.00	39.00	Microtendipes.sp.
.01	-9.00	46.00	Oecetis.sp.
.01	-9.00	20.00	Cryptochironomus.sp.
.01	-9.00	1.00	Ablabesmyia.sp.
.01	-9.00	54.00	Pisidium.casertanum
.01	.05	64.00	Polypedilum.sp.
.02	.03	70.00	Procladius.sp.
.02	.03	35.00	Limnodrilus.sp.
.03	.13	23.00	Gammarus.fasciatus
.03	.18	14.00	Chironomus.sp.
.03	.24	85.00	Tubifex.sp.
.03	-9.00	89.00	Valvata.tricarinata
.05	-9.00	71.00	Prostoma.rubrum
.05	-9.00	81.00	Stylaria.lacustris
.05	-9.00	4.00	Asellus.sp.
.06	-9.00	43.00	Nais.variabilis
.06	-9.00	18.00	Cricotopus.sp.
.06	-9.00	30.00	Hyalella.azteca
.06	-9.00	13.00	Cheumatopsyche.sp.
.07	-9.00	82.00	Stylodrilus.heringianus

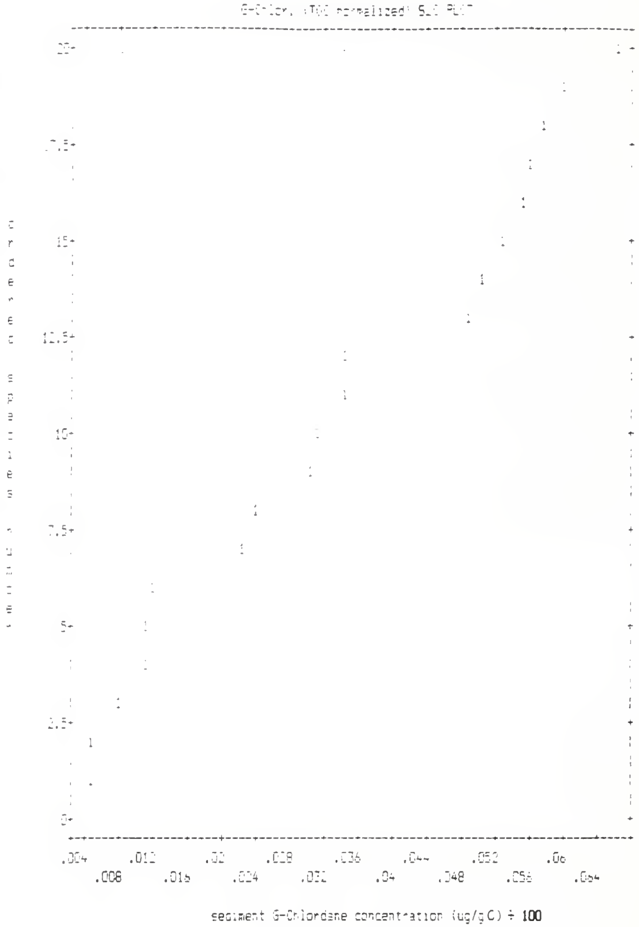

FIGURE C-31: SLC PLOT FOR γ-CHLORDANE

TABLE C-32: Species List for SLC Database

1 Ablabesmyia.sp.
2 Aeolosoma.sp.
3 Amnicola.limosa
4 Asellus.sp.
5 Aulodrilus.limnobius
6 Aulodrilus.pigueti
7 Aulodrilus.pleuriseta
8 Bithynia.tentaculata
9 Branchiura.sowerbyi
10 Caenis.sp.
11 Ceraclea.sp.
12 Chaetogaster.diaphanus
13 Cheumatopsyche.sp.
14 Chironomus.sp.
15 Cladopelma.sp.
16 Cladotanytarsus.sp.
17 Coelotanypus.sp.
18 Cricotopus.sp.
19 Cricotopus.vierriensis
20 Cryptochironomus.sp.
21 Dicrotendipes.sp.
22 Eukiefferiella.sp.
23 Gammarus.fasciatus
24 Glossiphonia.heteroclita
25 Glossosoma.sp.
26 Glyptotendipes.sp.
27 Gyraulus.parvus
28 Helisoma.anceps
29 Heterotrissocladius.sp.
30 Hyalella.azteca
31 Hydropsyche.sp.
32 Hydroptila.sp.
33 Ilyodrilus.templetoni
34 Limnodrilus.hoffmeisteri
35 Limnodrilus.sp.
36 Limnodrilus.udekemianus
37 Lumbriculus.variegatus
38 Manayunkia.speciosa
39 Microtendipes.sp.
40 Mystacides.sp.
41 Nais.behningi
42 Nais.communis
43 Nais.variabilis
44 Nanocladius.sp.
45 Neureclipsis.sp.
46 Oecetis.sp.
47 Parachironomus.sp.
48 Paralauterborniella.sp.
49 Paratendipes.sp.
50 Phaenopsectra.sp.
51 Phallodrilus.sp.
52 Physella.gyrina
53 Piguetiella.michiganensis
54 Pisidium.casertanum
55 Pisidium.compressum
56 Pisidium.conventus
57 Pisidium.fallax
58 Pisidium.henslowanum
59 Pisidium.lilljeborgi
60 Pisidium.nitidum
61 Pisidium.variabile
62 Pleurocera.acuta
63 Polypedilum.scalaenum
64 Polypedilum.sp.
65 Pontoporeia.hoyi
66 Potamothrix.moldaviensis
67 Potamothrix.vejdovskyi
68 Pristina.foreli
69 Pristina.osborni
70 Procladius.sp.
71 Prostoma.rubrum
72 Pseudocleon.sp.
73 Quistadrilus.multisetosus
74 Slavina.appendiculata
75 Specaria.josinae
76 Sphaerium.nitidum
77 Sphaerium.striatium
78 Spirosperma.ferox
79 Stenomena.sp.
80 Stictochironomus.sp.
81 Stylaria.lacustris
82 Stylodrilus.heringianus
83 Tanytarsus.sp.
84 Thienemannimyia.sp.
85 Tubifex.sp.
86 Turbellaria.sp.indet
87 Uncinais.uncinata
88 Valvata.sincera
89 Valvata.tricarinata
90 Vejdovskyella.intermedia
91 Elliptio.complanata
92 Sphaerium.simile
93 Chironomus.plumosus
94 Cricotopus.bicinctus
95 Ephemera.sp.
96 Helobdella.stagnalis
97 Hexagenia.limbata
98 Hexagenia.sp.
99 Tanypus.sp.
100 Tubifex.tubifex

APPENDIX D

Species Screening Level Concentrations and Plots for MOE In-Place Pollutants Data

- SSLC for each species is 90th percentile (P90) concentration all samples with that species present.

- Each table shows SSLCs (P90) for one contaminant, arranged in order of increasing concentration. P95, also shown, has some values missing (-9) due to small sample size.

- A corresponding SLC plot, with the same figure number as the table, shows the rank order of each SSLC against the corresponding SSLC concentration. Plot symbols indicate the number of SSLCs falling at the same plot position. The 5th percentile of this cumulative distribution is the contaminant SLC. (Where fewer than 20 species are included, the 10th percentile is used.)

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Table [illegible] Normalized Species SLC Values for
       [illegible] Log g 0.4.00 - In-Place Pollutants Data

  SED      PPT      SPN  SPECIES
 -----    -----   ------ --------------------------
  4.14    -9.00     8.00 Bithynia.tentaculata
  4.80     5.11     4.00 Asellus.sp.
  4.99     9.07    70.00 Procladius.sp.
  5.22    17.77    78.00 Spirosperma.ferox
  5.41     8.79    93.00 Tanytarsus.sp.
  5.61     7.14    67.00 Valvata.tricarinata
  5.55     9.03    54.00 Pisidium.casertanum
  5.66    13.53    55.00 Potamothrix.moldaviensis
  5.93     8.71    34.00 Limnodrilus.hoffmeisteri
  6.03    -9.00    65.00 Pontoporeia.hoyi
  6.41     9.43    51.00 Physella.gyrina
  6.57    10.97    95.00 Valvata.sincera
  7.08    11.38    20.00 Cryptochironomus.sp.
  7.15    -9.00    30.00 Hyalella.azteca
  7.44    13.35    14.00 Chironomus.sp.
  8.03    19.81   100.00 Tubifex.tubifex
  8.54    -9.00    31.00 Hydropsyche.sp.
  9.03    -9.00    16.00 Glyptotendipes.sp.
  9.38    17.79    71.00 Quistadrilus.multisetosus
  9.59    -9.00    84.00 Thienemannimyia.sp.
  9.76    11.38    11.00 Dicrotendipes.sp.
 10.01    10.59     3.00 Amnicola.limosa
 10.15    13.16    23.00 Gammarus.fasciatus
 11.21    16.90    93.00 Chironomus.plumosus
 11.77    -9.00    97.00 Hexagenia.limbata
 15.14    -9.00    17.00 Gyraulus.parvus
 15.41    -9.00    77.00 Sphaerium.striatum
 20.91    -9.00    36.00 Limnodrilus.udekemianus
 21.33    -9.00    46.00 Oecetis.sp.
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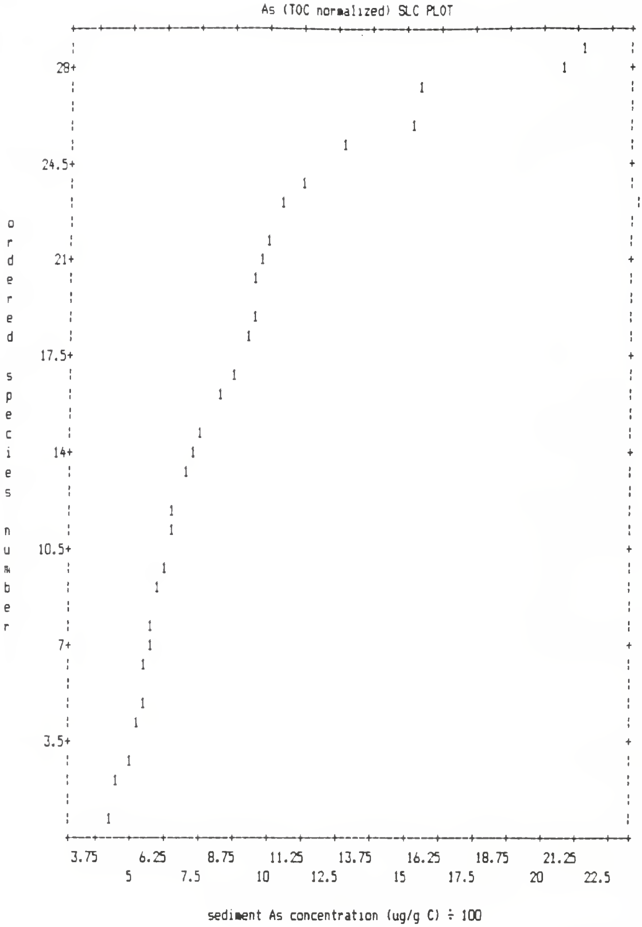


FIGURE D-1: SLC PLOT FOR ARSENIC

[illegible]

[illegible]	[illegible]	[illegible]	SPECIES
[illegible]	[illegible]	[illegible]	Bithynia.tentaculata
[illegible]	[illegible]	[illegible]	Asellus.sp.
[illegible]	[illegible]	[illegible]	Thienemannimyia.sp.
[illegible]	[illegible]	[illegible]	Procladius.sp.
[illegible]	[illegible]	[illegible]	Spirosperma.ferox
[illegible]	[illegible]	[illegible]	Physella.gyrina
44.[illegible]	[illegible]	14.[illegible]	Chironomus.sp.
44.	44.[illegible]	[illegible]	Valvata.tricarinata
45	71.41	[illegible]	Limnodrilus.hoffmeisteri
[illegible]	[illegible]	[illegible]	Tanytarsus.sp.
[illegible]	[illegible]	54.[illegible]	Pisidium.casertanum
[illegible]	[illegible]	[illegible]	Hydropsyche.sp.
[illegible]	[illegible]	[illegible]	Hyalella.azteca
[illegible]	[illegible]	[illegible]	Gyraulus.parvus
[illegible]	[illegible]	[illegible]	Quistadrilus.multisetosus
[illegible]	[illegible]	[illegible]	Gammarus.fasciatus
[illegible]	[illegible]	[illegible]	Chironomus.plumosus
[illegible]	[illegible]	[illegible]	Dicrotendipes.sp.
[illegible]	[illegible]	100.00	Tubifex.tubifex
[illegible]	[illegible]	[illegible]	Cryptochironomus.sp.
[illegible]	[illegible]	[illegible]	Amnicola.limosa
[illegible]	[illegible]	[illegible]	Valvata.sincera
74.4	[illegible]	[illegible]	Hexagenia.limbata
[illegible]	[illegible]	[illegible]	Pontoporeia.hoyi
[illegible]	[illegible]	[illegible]	Oecetis.sp.
105.85	[illegible]	[illegible]	Potamothrix.moldaviensis
[illegible]	[illegible]	[illegible]	Limnodrilus.udekemianus
[illegible]	[illegible]	[illegible]	Sphaerium.striatinum
[illegible]	[illegible]	[illegible]	Glyptotendipes.sp.

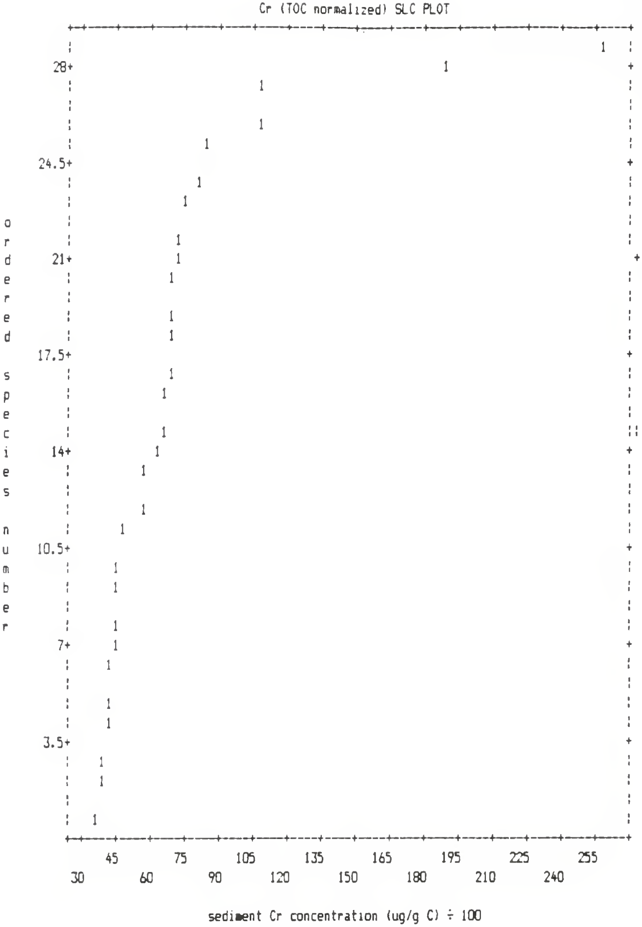


FIGURE D-2: SLC PLOT FOR CHROMIUM

TABLE D-3: TOC Normalized Species SLC Values for
1% ug/g C.#100 - In-Place Pollutant Data

P90	P95	SPN.	SPECIES
13.09	-9.00	16.00	Glyptotendipes.sp.
25.11	39.14	4.00	Asellus.sp.
35.00	42.41	75.00	Procladius.sp.
35.70	-9.00	8.00	Bithynia.tentaculata
37.56	49.10	52.00	Physella.gyrina
37.57	67.00	53.00	Tanytarsus.sp.
38.00	-9.00	27.00	Gyraulus.parvus
39.36	40.00	89.00	Valvata.tricarinata
39.57	45.60	75.00	Spirosperma.ferox
44.00	88.67	14.00	Chironomus.sp.
44.33	51.20	88.00	Valvata.sincera
45.80	77.11	13.00	Gammarus.fasciatus
47.10	51.60	21.00	Dicrotendipes.sp.
47.20	53.87	54.00	Pisidium.casertanum
49.11	-9.00	64.00	Thienemannimyia.sp.
50.41	73.35	3.00	Amnicola.limosa
51.60	-9.00	46.00	Oecetis.sp.
52.33	150.60	72.00	Quistadrilus.multisetosus
52.37	79.39	11.00	Cryptochironomus.sp.
53.62	77.58	34.00	Limnodrilus.hoffmeisteri
54.30	-9.00	65.00	Pontoporeia.hoyi
60.41	319.79	93.00	Chironomus.plumosus
61.72	1226.40	56.00	Potamothrix.moldaviensis
63.50	78.53	100.00	Tubifex.tubifex
71.90	-9.00	97.00	Hexagenia.limbata
91.00	-9.00	30.00	Hyalella.azteca
104.00	-9.00	31.00	Hydropsyche.sp.
121.50	-9.00	36.00	Limnodrilus.udekemianus
154.90	-9.00	77.00	Sphaerium.striatum

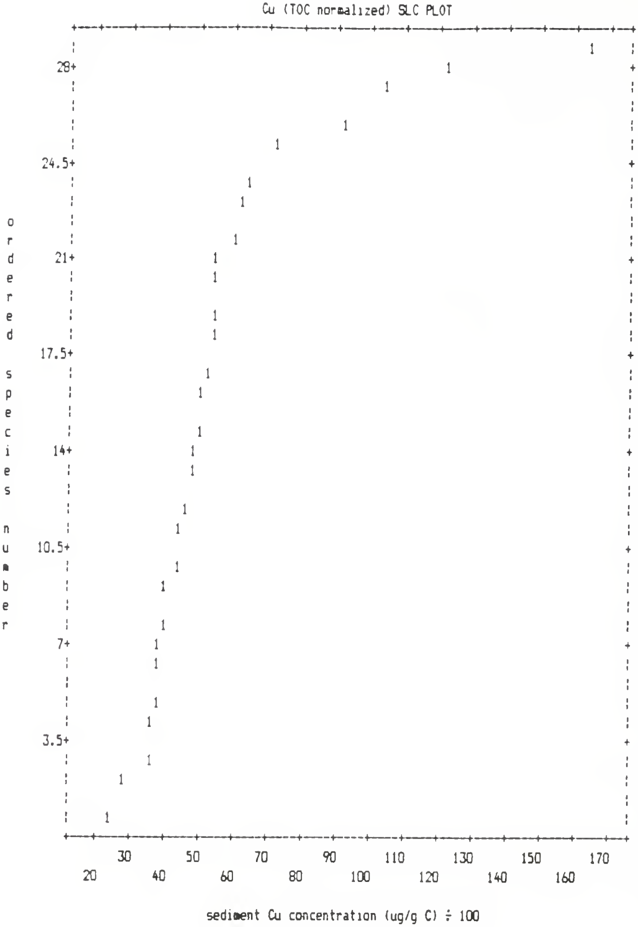


FIGURE D-3: SLC PLOT FOR COPPER

TABLE D-4: TIC Normalized Species SLC Values for
Fe (ug/g OC)÷100 - In-Place Pollutant Data

P50	P95	SPNO	SPECIES
15590.00	-9.00	8.00	Bithynia.tentaculata
19957.14	40457.14	78.00	Spirosperma.ferox
20835.46	28425.71	4.00	Asellus.sp.
22857.14	37000.00	34.00	Limnodrilus.hoffmeisteri
24000.00	39400.00	14.00	Chironomus.sp.
24018.37	-9.00	26.00	Glyptotendipes.sp.
24480.00	36760.00	70.00	Procladius.sp.
26139.70	-9.00	84.00	Thienemannimyia.sp.
27600.00	29120.00	52.00	Physella.gyrina
28060.00	55200.00	54.00	Pisidium.casertanum
28280.00	61191.67	23.00	Gammarus.fasciatus
29600.00	-9.00	31.00	Hydropsyche.sp.
30960.00	40960.00	88.00	Valvata.sincera
30994.29	86400.00	73.00	Quistadrilus.multisetosus
32240.00	160560.0	89.00	Valvata.tricarinata
33200.00	-9.00	30.00	Hyalella.azteca
34240.00	67866.57	100.00	Tubifex.tubifex
34850.00	-9.00	97.00	Hexagenia.limbata
37040.00	68720.00	66.00	Potamothrix.moldaviensis
38135.14	158000.0	83.00	Tanytarsus.sp.
41400.00	-9.00	27.00	Gyraulus.parvus
41600.00	73000.00	20.00	Cryptochironomus.sp.
41600.00	-9.00	65.00	Pontoporeia.hoyi
42200.00	71708.34	93.00	Chironomus.plumosus
42720.00	97600.00	3.00	Amnicola.limosa
45360.00	177600.0	21.00	Dicrotendipes.sp.
59840.00	-9.00	77.00	Sphaerium.striatium
66266.67	-9.00	36.00	Limnodrilus.udekemianus
177600.0	-9.00	46.00	Oecetis.sp.

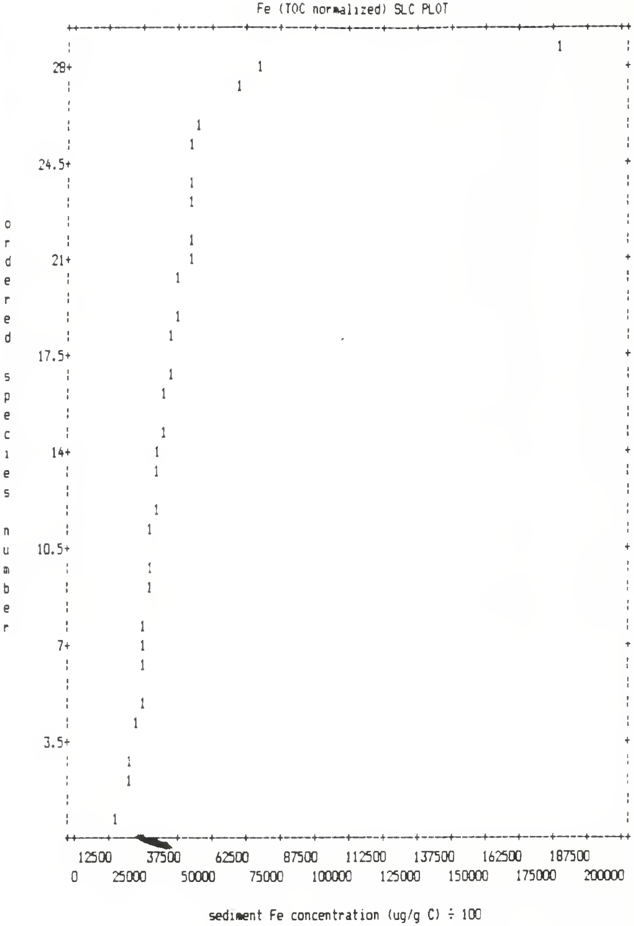


FIGURE D-4: SLC PLOT FOR IRON

TABLE D-5: TOC-Normalized Species SLC Values for Hg ((ug/g C)÷100) - In-Place Pollutants Data

P90	P95	SPNO	SPECIES
5.16	-9.00	26.00	Glyptotendipes.sp.
14.38	22.26	93.00	Chironomus.plumosus
15.14	24.63	20.00	Cryptochironomus.sp.
17.99	21.32	83.00	Tanytarsus.sp.
17.99	26.29	100.00	Tubifex.tubifex
19.83	64.12	66.00	Potamothrix.moldaviensis
20.97	-9.00	65.00	Pontoporeia.hoyi
23.68	53.78	34.00	Limnodrilus.hoffmeisteri
27.75	57.57	4.00	Asellus.sp.
30.98	95.60	70.00	Procladius.sp.
32.54	-9.00	8.00	Bithynia.tentaculata
33.49	126.80	54.00	Pisidium.casertanum
48.33	127.78	14.00	Chironomus.sp.
56.69	122.40	73.00	Quistadrilus.multisetosus
69.84	-9.00	30.00	Hyalella.azteca
73.38	170.11	88.00	Valvata.sincera
73.67	-9.00	36.00	Limnodrilus.udekemianus
75.59	178.12	3.00	Amnicola.limosa
76.69	191.88	23.00	Gammarus.fasciatus
78.49	-9.00	77.00	Sphaerium.striatium
92.48	-9.00	31.00	Hydropsyche.sp.
113.46	181.85	78.00	Spirosperma.ferox
125.77	184.45	89.00	Valvata.tricarinata
130.73	-9.00	97.00	Hexagenia.limbata
134.83	-9.00	27.00	Gyraulus.parvus
167.72	195.37	21.00	Dicrotendipes.sp.
171.44	193.78	52.00	Physella.gyrina
177.09	-9.00	84.00	Thienemannimyia.sp.
195.37	-9.00	46.00	Oecetis.sp.

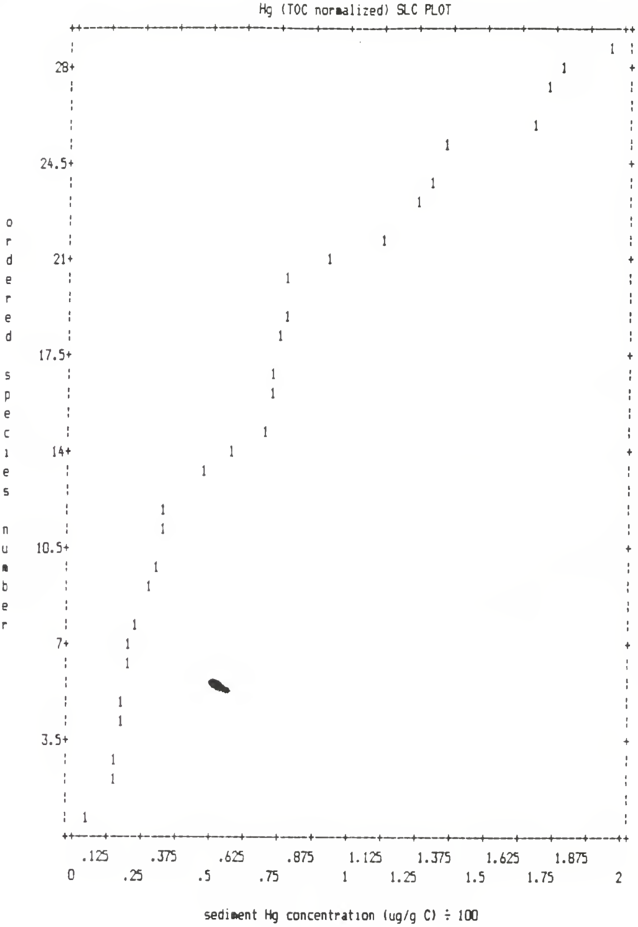


FIGURE D-5: SLC PLOT FOR MERCURY

TABLE D-5: TOC Normalized Species SLC values for
Zn (ug/g O.#100) - In-Place Pollutants Data

P90	P95	SPNO	SPECIES
100.09	146.59	92.00	Tanytarsus.sp.
103.76	156.51	78.00	Spirosperma.ferox
108.43	233.21	4.00	Asellus.sp.
113.76	214.75	70.00	Procladius.sp.
116.80	168.00	89.00	Valvata.tricarinata
126.41	215.91	54.00	Pisidium.casertanum
133.34	-9.00	5.00	Bithynia.tentaculata
140.00	-9.00	27.00	Gyraulus.parvus
140.79	-9.00	84.00	Thienemannimyia.sp.
151.52	188.38	93.00	Chironomus.plumosus
170.17	319.58	52.00	Physella.gyrina
170.73	207.57	34.00	Limnodrilus.hoffmeisteri
173.60	352.80	21.00	Dicrotendipes.sp.
177.03	213.40	88.00	Valvata.sincera
178.57	230.00	14.00	Chironomus.sp.
183.20	-9.00	97.00	Hexagenia.limbata
189.31	290.73	100.00	Tubifex.tubifex
201.00	283.76	20.00	Cryptochironomus.sp.
204.47	322.49	23.00	Gammarus.fasciatus
205.33	702.97	3.00	Amnicola.limosa
211.47	263.23	66.00	Potamothrix.moldaviensis
216.74	508.69	73.00	Quistadrilus.multisetosus
228.00	-9.00	65.00	Pontoporeia.hoyi
252.00	-9.00	30.00	Hyalella.azteca
273.11	-9.00	31.00	Hydropsyche.sp.
280.73	-9.00	36.00	Limnodrilus.udekemianus
349.60	-9.00	46.00	Oecetis.sp.
509.00	-9.00	77.00	Sphaerium.striatium
567.14	-9.00	26.00	Glyptotendipes.sp.

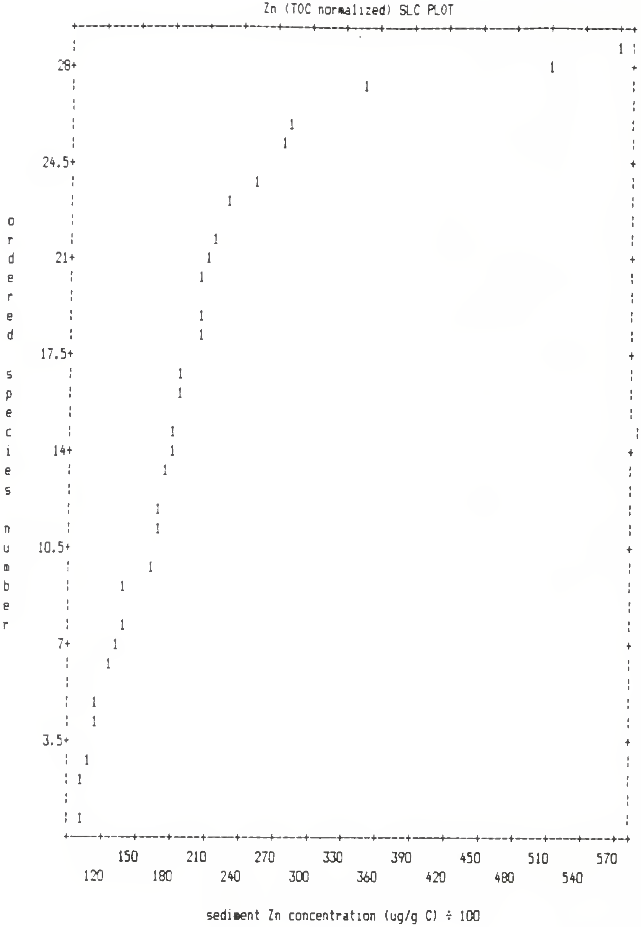


FIGURE D-6: SLC PLOT FOR ZINC

TABLE D-7: 90 Normalized Species SLC Values for
PCBs (ug/g C/÷100) - In-Place Pollutants Data

P90	P95	SPN.	SPECIES
.04	-9.00	5.00	Bithynia.tentaculata
.05	-9.00	27.00	Gyraulus.parvus
.05	.12	93.00	Tanytarsus.sp.
.05	-9.00	26.00	Glyptotendipes.sp.
.05	.13	66.00	Potamothrix.moldaviensis
.06	.12	89.00	Valvata.tricarinata
.08	.16	54.00	Pisidium.casertanum
.09	.16	20.00	Cryptochironomus.sp.
.10	-9.00	97.00	Hexagenia.limbata
.11	.42	4.00	Asellus.sp.
.12	.33	14.00	Chironomus.sp.
.12	.40	93.00	Chironomus.plumosus
.13	-9.00	33.00	Hyalella.azteca
.13	.26	34.00	Limnodrilus.hoffmeisteri
.14	.30	70.00	Procladius.sp.
.14	.34	3.00	Amnicola.limosa
.14	-9.00	21.00	Dicrotendipes.sp.
.14	.29	23.00	Gammarus.fasciatus
.15	.27	88.00	Valvata.sincera
.21	.35	100.00	Tubifex.tubifex
.22	.40	73.00	Quistadrilus.multisetosus
.23	.38	78.00	Spirosperma.ferox
.27	.39	52.00	Physella.gyrina
.31	-9.00	65.00	Pontoporeia.hoyi
.39	-9.00	31.00	Hydropsyche.sp.
.67	-9.00	36.00	Limnodrilus.udekemianus
.72	-9.00	77.00	Sphaerium.striatum

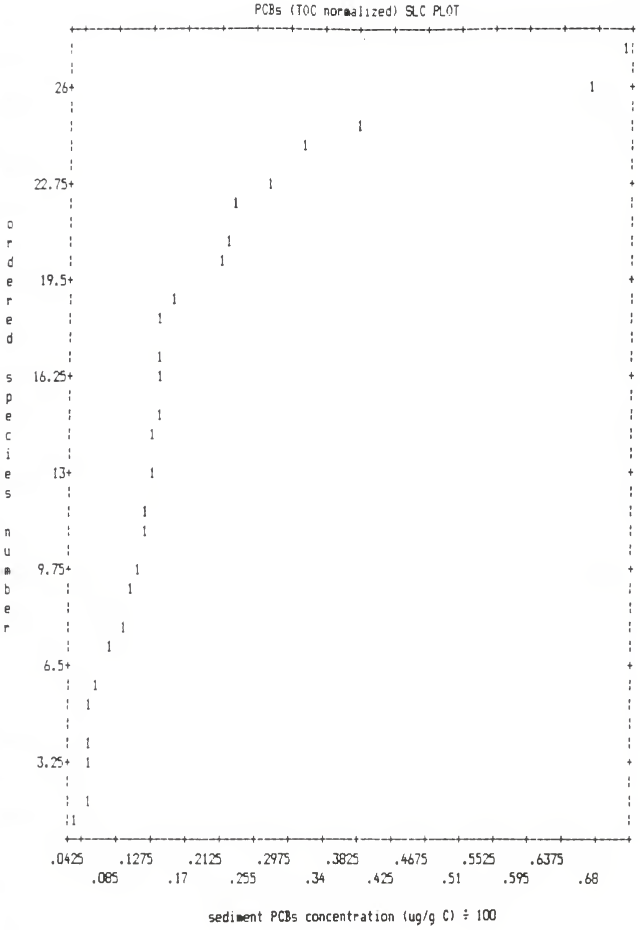


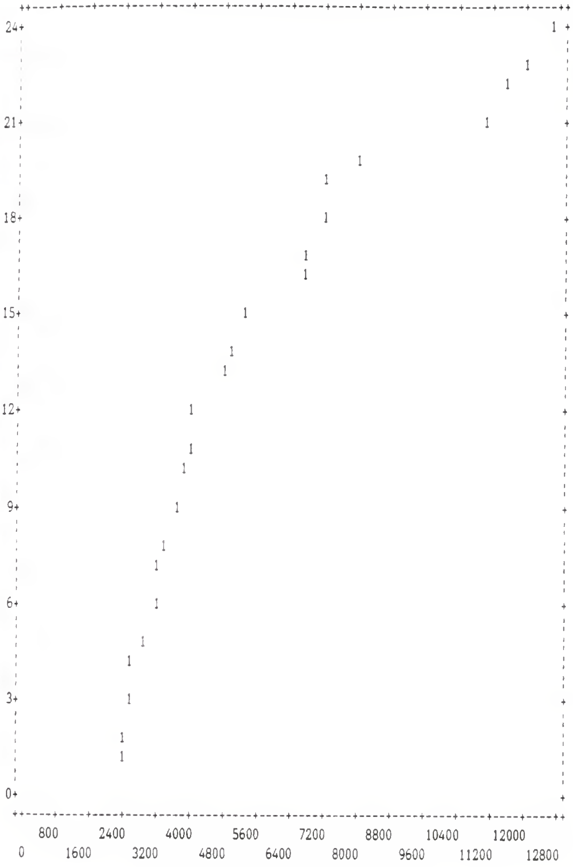
FIGURE D-7: SLC PLOT FOR PCBs

P90

Bulk Sediment Species SLC for Solvent Extractables.

```
                                                  Valid     Cum
 Value Label              Value  Frequency  Percent  Percent  Percent

                        2385.60          1      4.2      4.2      4.2
                        2400.40          1      4.2      4.2      8.3
                        2484.00          1      4.2      4.2     12.5
                        2603.30          1      4.2      4.2     16.7
                        2800.00          1      4.2      4.2     20.8
                        3217.90          1      4.2      4.2     25.0
                        3227.00          1      4.2      4.2     29.2
                        3332.60          1      4.2      4.2     33.3
                        3684.90          1      4.2      4.2     37.5
                        3821.70          1      4.2      4.2     41.7
                        4022.00          1      4.2      4.2     45.8
                        4027.60          1      4.2      4.2     50.0
                        4730.80          1      4.2      4.2     54.2
                        4908.80          1      4.2      4.2     58.3
                        5337.00          1      4.2      4.2     62.5
                        6677.80          1      4.2      4.2     66.7
                        6680.50          1      4.2      4.2     70.8
                        7271.20          1      4.2      4.2     75.0
                        7278.80          1      4.2      4.2     79.2
                        8003.50          1      4.2      4.2     83.3
                       11028.60          1      4.2      4.2     87.5
                       11587.00          1      4.2      4.2     91.7
                       11991.60          1      4.2      4.2     95.8
                       12569.00          1      4.2      4.2    100.0
                                   -------  -------  -------
                          TOTAL         24    100.0    100.0

Percentile     Value      Percentile     Value

   5.00     2389.300        10.00     2442.200

Valid Cases        24     Missing Cases      0
```

Solvent Extractables SLC PLOT



sediment Solvent Extractables (ug/g)

24 cases plotted.

TABLE D-8: COMPARISON OF SLC VALUES BASED ON MOE IN-PLACE POLLUTANTS DATA WITH VALUES BASED ON THE MAIN DATABASE

Parameter	SLC from Table 3.11		SLC from MOE Data	
	(ug/g C)	(ug/g)[1]	(ug/g C)	(ug/g)[1]
Arsenic	980	39	437	17
Chromium	3,370	134	3,753	150
Copper	2,320	93	2,565	102
Iron	*	-	*	-
Mercury	11	0.44	10	0.40
Zinc	14,080	563	10,342	413
PCBs	16.4	0.65	4.1	0.16

[1] Conversion from ug/g C to ug/g assumes an average 4% total organic carbon. Actual average TOC values were approximately 2% and 3%, respectively, for the main and MOE databases.

* TOC-normalized SLC for iron greater than g/g.

APPENDIX E

Species Screening Level Concentrations and Plots for Combined Data from Appendix C and Appendix D

- SSLC for each species is 90th percentile (P90) concentration all samples with that species present.

- Each table shows SSLCs (P90) for one contaminant, arranged in order of increasing concentration. P95, also shown, has some missing values (-9) due to small sample size.

- A corresponding SLC plot, with the same figure number as the table, shows the rank order of each SSLC against the corresponding SSLC concentration. Plot symbols indicate the number of SSLCs falling at the same plot position. The 5th percentile of this cumulative distribution is the contaminant SLC. (Where fewer than 20 species are included, the 10th percentile is used.

- SLC calculations for total P, TKN, and TOC are based on bulk sediment values. These are indicators of sediment enrichment and reflect accompanying environmental changes such as oxygen depletion. They are not to be considered indicative of "toxic" levels since it is unlikely these nutrients are truly toxic.

- Numbering of the tables follows the system of Appendix C to facilitate comparison. Only those parameters that occured above detection limits at sufficient frequency are included.

TABLE E-1: TOC Normalized Species SLC Values for
As ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
4.68	10.01	4.00	Asellus.sp.
4.89	5.06	96.00	Helobdella.stagnalis
5.32	-9.00	26.00	Glyptotendipes.sp.
7.09	10.06	6.00	Aulodrilus.piqueti
7.16	12.34	75.00	Specaria.josinae
7.93	17.71	100.00	Tubifex.tubifex
8.22	-9.00	17.00	Coelotanypus.sp.
9.07	13.09	34.00	Limnodrilus.hoffmeisteri
9.21	-9.00	33.00	Ilyodrilus.templetoni
9.64	230.78	7.00	Aulodrilus.pleuriseta
9.71	-9.00	9.00	Branchiura.sowerbyi
9.83	15.75	89.00	Valvata.tricarinata
9.83	17.68	30.00	Hyalella.azteca
10.05	13.28	21.00	Dicrotendipes.sp.
10.20	-9.00	97.00	Hexagenia.limbata
10.95	28.53	46.00	Oecetis.sp.
11.17	-9.00	40.00	Mystacides.sp.
11.32	12.93	70.00	Procladius.sp.
11.49	16.25	85.00	Tubifex.sp.
11.57	14.77	88.00	Valvata.sincera
11.58	20.63	16.00	Cladotanytarsus.sp.
11.64	12.31	35.00	Limnodrilus.sp.
11.87	19.94	20.00	Cryptochironomus.sp.
11.88	17.18	65.00	Pontoporeia.hoyi
11.93	21.06	73.00	Quistadrilus.multisetosus
12.06	19.67	93.00	Chironomus.plumosus
12.78	21.40	59.00	Pisidium.lilljeborgi
12.86	763.15	10.00	Caenis.sp.
13.05	-9.00	39.00	Microtendipes.sp.
13.19	-9.00	47.00	Parachironomus.sp.
13.20	50.28	49.00	Paratendipes.sp.
13.32	15.97	81.00	Stylaria.lacustris
13.39	37.60	14.00	Chironomus.sp.
13.39	19.30	50.00	Phaenopsectra.sp.
13.76	35.71	3.00	Amnicola.limosa
14.09	19.26	36.00	Limnodrilus.udekemianus
14.32	88.07	66.00	Potamothrix.moldaviensis
14.61	-9.00	76.00	Sphaerium.nitidum
15.12	22.64	1.00	Ablabesmyia.sp.
15.42	17.86	61.00	Pisidium.variabile
15.84	363.41	60.00	Pisidium.nitidum
15.88	32.67	51.00	Phallodrilus.sp.
16.35	37.98	23.00	Gammarus.fasciatus
16.42	49.99	58.00	Pisidium.henslowanum
16.46	33.09	54.00	Pisidium.casertanum
17.54	-9.00	56.00	Pisidium.conventus
17.72	169.31	12.00	Chaetogaster.diaphanus
17.91	53.49	78.00	Spirosperma.ferox
17.91	53.49	83.00	Tanytarsus.sp.
18.13	34.70	15.00	Cladopelma.sp.
18.27	51.18	64.00	Polypedilum.sp.
18.39	39.77	52.00	Physella.gyrina
19.53	-9.00	63.00	Polypedilum.scalaenum
19.79	-9.00	28.00	Helisoma.anceps
19.83	27.29	27.00	Gyraulus.parvus
20.58	79.27	22.00	Eukiefferiella.sp.
20.75	48.36	43.00	Nais.variabilis
20.75	40.61	84.00	Thienemannimyia.sp.
23.06	-9.00	55.00	Pisidium.compressum
23.54	73.33	67.00	Potamothrix.vejdovskyi
26.28	65.71	13.00	Cheumatopsyche.sp.
26.56	74.42	90.00	Vejdovskyella.intermedia
26.65	89.98	8.00	Bithynia.tentaculata
27.21	407.89	87.00	Uncinais.uncinata
27.38	68.62	25.00	Glossosoma.sp.
27.92	88.83	31.00	Hydropsyche.sp.
28.30	61.35	82.00	Stylodrilus.heringianus
28.40	587.05	44.00	Nanocladius.sp.
28.59	107.52	71.00	Prostoma.rubrum
29.50	-9.00	72.00	Pseudocleon.sp.
30.21	89.58	86.00	Turbellaria.sp.indet
30.51	56.74	45.00	Neureclipsis.sp.
32.89	-9.00	2.00	Aeolosoma.sp.
33.96	105.81	79.00	Stenonema.sp.
34.89	90.37	57.00	Pisidium.fallax
35.77	323.47	18.00	Cricotopus.sp.
37.44	309.00	53.00	Piguetiella.michiganensis
37.74	86.32	77.00	Sphaerium.striatium
37.88	366.92	32.00	Hydroptila.sp.
37.88	89.58	62.00	Pleurocera.acuta
38.33	534.40	42.00	Nais.communis
40.11	132.18	11.00	Ceraclea.sp.
44.97	587.05	74.00	Slavina.appendiculata
49.36	336.02	5.00	Aulodrilus.limnobius
57.52	140.33	38.00	Manayunkia.speciosa
60.55	609.43	41.00	Nais.behningi
90.05	1055.10	37.00	Lumbriculus.variegatus
91.03	403.00	69.00	Pristina.osborni
146.06	-9.00	29.00	Heterotrissocladius.sp.
199.27	-9.00	48.00	Paralauterborniella.sp.
291.75	-9.00	68.00	Pristina.foreli

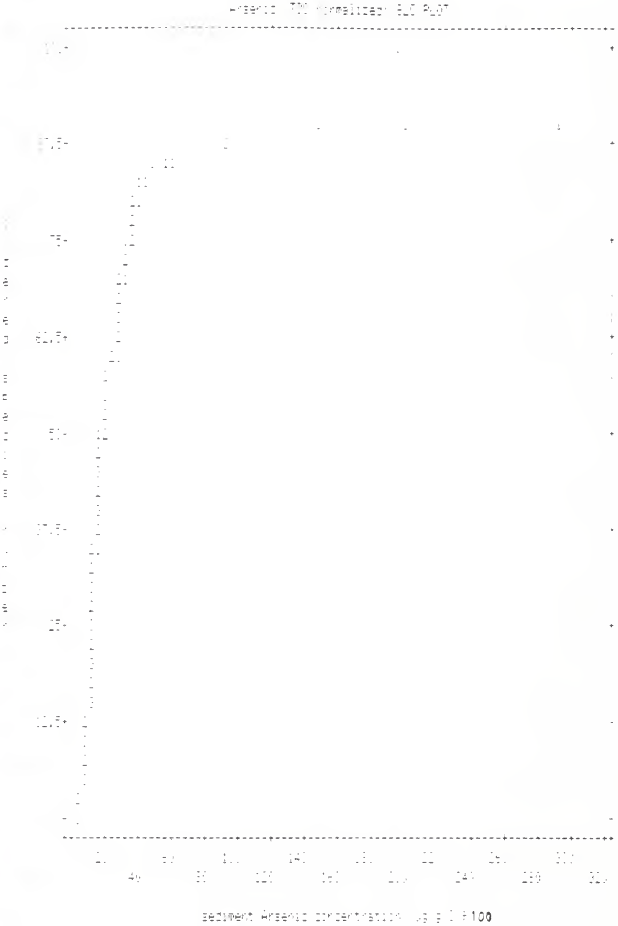


FIGURE E-1: SLC PLOT FOR ARSENIC

TABLE E-3. [illegible] Normalized Species [illegible] values for
Dr[illegible] [illegible] #100

P90	P95	SPNO	SPECIES
18.11	36.15	96.00	Helobdella.stagnalis
24.11	-9.00	17.00	Coelotanypus.sp.
33.11	52.99	4.00	Asellus.sp.
35.01	72.00	59.00	Pisidium.lilljeborgi
40.22	-9.00	56.00	Pisidium.conventus
43.15	59.99	27.00	Gyraulus.parvus
45.04	51.81	38.00	Limnodrilus.sp.
46.40	-9.00	47.00	Parachironomus.sp.
48.34	51.03	85.00	Tubifex.sp.
49.50	71.61	70.00	Procladius.sp.
51.40	-9.00	80.00	Stictochironomus.sp.
52.28	76.41	21.00	Dicrotendipes.sp.
52.51	-9.00	9.00	Branchiura.sowerbyi
52.56	-9.00	76.00	Sphaerium.nitidum
54.11	68.53	99.00	Valvata.tricarinata
55.61	-9.00	33.00	Ilyodrilus.templetoni
55.75	97.53	14.00	Chironomus.sp.
58.15	74.11	34.00	Limnodrilus.hoffmeisteri
58.54	80.40	65.00	Pontoporeia.hoyi
58.64	74.11	50.00	Phaenopsectra.sp.
59.21	73.01	6.00	Aulodrilus.pigueti
59.81	680.36	12.00	Chaetogaster.diaphanus
60.40	73.31	61.00	Pisidium.variabile
61.21	-9.00	40.00	Mystacides.sp.
62.53	113.52	15.00	Cladopelma.sp.
62.83	76.74	88.00	Valvata.sincera
63.15	935.71	7.00	Aulodrilus.pluriseta
63.16	81.27	75.00	Specaria.josinae
64.11	-9.00	19.00	Helisoma.anceps
64.44	91.53	46.00	Oecetis.sp.
65.67	70.66	93.00	Chironomus.plumosus
67.54	129.11	1.00	Ablabesmyia.sp.
68.33	92.40	20.00	Cryptochironomus.sp.
69.53	101.81	100.00	Tubifex.tubifex
70.40	179.09	8.00	Bithynia.tentaculata
70.40	1455.71	60.00	Pisidium.nitidum
71.01	109.09	30.00	Hyalella.azteca
72.00	254.76	73.00	Quistadrilus.multisetosus
72.00	-9.00	97.00	Hexagenia.limbata
72.15	824.60	10.00	Caenis.sp.
73.33	-9.00	63.00	Polypedilum.scalaenum
75.43	-9.00	39.00	Microtendipes.sp.
75.49	145.01	83.00	Tanytarsus.sp.
76.51	179.14	49.00	Paratendipes.sp.
78.15	189.53	90.00	Vejdovskyella.intermedia
78.33	92.64	81.00	Stylaria.lacustris
78.61	171.52	84.00	Thienemannimyia.sp.
78.90	133.30	43.00	Nais.variabilis
78.95	111.50	52.00	Physella.gyrina
80.19	132.15	54.00	Pisidium.casertanum
80.47	142.71	3.00	Amnicola.limosa
80.91	150.80	78.00	Spirosperma.ferox
81.46	131.03	35.00	Limnodrilus.udekemianus
83.51	131.63	64.00	Polypedilum.sp.
83.93	219.81	16.00	Cladotanytarsus.sp.
85.75	219.81	23.00	Gammarus.fasciatus
93.81	-9.00	55.00	Pisidium.compressum
96.07	-9.00	26.00	Glyptotendipes.sp.
96.25	151.16	58.00	Pisidium.henslowanum
96.36	256.19	22.00	Eukiefferiella.sp.
96.78	1396.50	53.00	Piguetiella.michiganensis
101.50	-9.00	72.00	Pseudocloeon.sp.
109.35	1294.29	5.00	Aulodrilus.limnobius
110.50	233.19	25.00	Glossosoma.sp.
117.50	149.54	45.00	Neureclipsis.sp.
117.50	237.21	82.00	Stylodrilus.heringianus
121.79	237.38	13.00	Cheumatopsyche.sp.
122.00	252.39	51.00	Phallodrilus.sp.
123.82	285.93	67.00	Potamothrix.vejdovskyi
127.11	1820.00	42.00	Nais.communis
129.50	274.25	86.00	Turbellaria.sp.indet
129.81	1440.91	66.00	Potamothrix.moldaviensis
130.18	676.90	74.00	Slavina.appendiculata
131.32	572.96	32.00	Hydroptila.sp.
132.29	237.38	77.00	Sphaerium.striatium
144.17	253.63	79.00	Stenonema.sp.
145.46	278.29	57.00	Pisidium.fallax
148.57	312.99	71.00	Prostoma.rubrum
157.44	297.40	62.00	Pleurocera.acuta
159.97	914.55	18.00	Cricotopus.sp.
160.89	1153.64	36.00	Manayunkia.speciosa
163.38	355.84	11.00	Ceraclea.sp.
169.23	261.61	31.00	Hydropsyche.sp.
203.37	754.17	44.00	Nanocladius.sp.
205.56	1643.75	87.00	Uncinais.uncinata
210.19	-9.00	2.00	Aeolosoma.sp.
247.33	3605.29	41.00	Nais.behningi
251.38	1580.00	37.00	Lumbriculus.variegatus
281.67	1584.55	69.00	Pristina.osborni
476.85	-9.00	29.00	Heterotrissocladius.sp.
794.55	-9.00	48.00	Paralauterborniella.sp.
1138.43	-9.00	68.00	Pristina.foreli

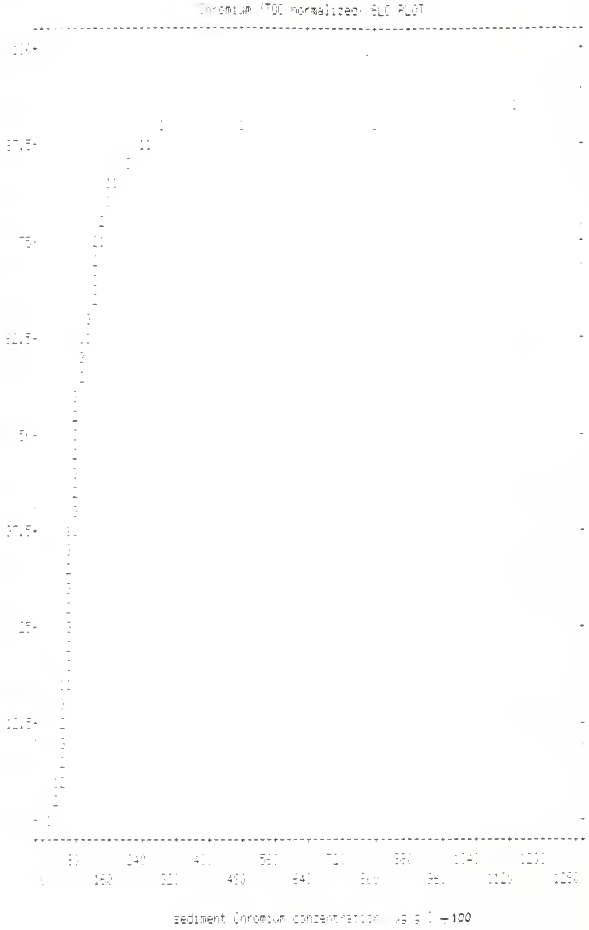


FIGURE E-3: SLC PLOT FOR CHROMIUM

TABLE E-4: TOC Normalized Species SLC Values for
Cu ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
18.99	-9.00	17.00	Coelotanypus.sp.
19.70	-9.00	9.00	Branchiura.sowerbyi
21.89	23.13	26.00	Glyptotendipes.sp.
25.27	43.18	59.00	Pisidium.lilljeborgi
25.50	35.84	95.00	Helobdella.stagnalis
26.90	36.81	4.00	Asellus.sp.
28.04	-9.00	80.00	Stictochironomus.sp.
28.10	60.87	27.00	Gyraulus.parvus
28.89	37.25	75.00	Specaria.josinae
30.47	-9.00	76.00	Sphaerium.nitidum
30.91	257.78	7.00	Aulodrilus.pleuriseta
31.86	-9.00	56.00	Pisidium.conventus
32.31	-9.00	24.00	Glossiphonia.heteroclita
32.42	37.07	6.00	Aulodrilus.piqueti
33.04	407.11	60.00	Pisidium.nitidum
33.68	-9.00	47.00	Parachironomus.sp.
35.17	52.20	61.00	Pisidium.variabile
35.88	42.61	70.00	Procladius.sp.
36.76	46.00	65.00	Pontoporeia.hoyi
37.04	71.36	8.00	Bithynia.tentaculata
37.11	486.20	10.00	Caenis.sp.
38.19	42.44	89.00	Valvata.tricarinata
38.34	45.80	50.00	Phaenopsectra.sp.
39.09	57.73	46.00	Oecetis.sp.
39.11	44.74	88.00	Valvata.sincera
39.29	46.15	14.00	Chironomus.sp.
39.59	47.20	21.00	Dicrotendipes.sp.
40.46	45.58	81.00	Stylaria.lacustris
40.85	77.99	20.00	Cryptochironomus.sp.
40.86	86.76	79.00	Spirosperma.ferox
40.98	79.23	35.00	Limnodrilus.sp.
41.81	-9.00	91.00	Elliptio.complanata
41.88	85.48	83.00	Tanytarsus.sp.
42.33	47.95	15.00	Cladopelma.sp.
42.35	96.15	52.00	Physella.gyrina
42.38	90.98	55.00	Pisidium.compressum
42.53	401.43	32.00	Hydroptila.sp.
44.34	79.65	1.00	Ablabesmyia.sp.
44.61	81.41	34.00	Limnodrilus.hoffmeisteri
44.95	48.41	49.00	Paratendipes.sp.
45.00	85.30	54.00	Pisidium.casertanum
45.86	1273.63	85.00	Tubifex.sp.
46.01	230.11	12.00	Chaetogaster.diaphanus
47.79	112.40	92.00	Sphaerium.simile
47.83	-9.00	40.00	Mystacides.sp.
49.56	78.95	93.00	Chironomus.plumosus
50.07	91.53	51.00	Phallodrilus.sp.
50.80	101.56	3.00	Amnicola.limosa
51.38	75.64	58.00	Pisidium.henslowanum
52.00	-9.00	97.00	Hexagenia.limbata
52.10	-9.00	33.00	Ilyodrilus.templetoni
53.08	150.29	16.00	Cladotanytarsus.sp.
53.66	226.57	73.00	Quistadrilus.multisetosus
54.22	366.67	53.00	Piquetiella.michiganensis
56.25	112.99	23.00	Gammarus.fasciatus
56.27	-9.00	39.00	Microtendipes.sp.
56.43	110.67	64.00	Polypedilum.sp.
57.16	113.59	84.00	Thienemannimyia.sp.
57.46	188.79	43.00	Nais.variabilis
60.81	439.29	66.00	Potamothrix.moldaviensis
61.26	108.91	77.00	Sphaerium.striatum
61.94	147.71	82.00	Stylodrilus.heringianus
62.44	540.00	42.00	Nais.communis
63.10	90.42	90.00	Vejdovskyella.intermedia
63.12	78.06	100.00	Tubifex.tubifex
65.09	99.83	45.00	Neureclipsis.sp.
66.04	-9.00	63.00	Polypedilum.scalaenum
66.62	-9.00	28.00	Helisoma.anceps
67.60	127.44	67.00	Potamothrix.vejdovskyi
70.59	116.13	30.00	Hyalella.azteca
77.01	189.05	36.00	Limnodrilus.udekemianus
77.14	133.38	13.00	Cheumatopsyche.sp.
85.16	375.71	5.00	Aulodrilus.limnobius
85.25	405.77	74.00	Slavina.appendiculata
96.70	407.50	44.00	Nanocladius.sp.
97.17	163.72	25.00	Glossosoma.sp.
100.27	232.45	86.00	Turbellaria.sp.indet
103.32	235.24	11.00	Ceraclea.sp.
103.93	236.12	57.00	Pisidium.fallax
104.92	247.86	79.00	Stenonema.sp.
105.09	390.71	38.00	Manayunkia.speciosa
105.84	197.14	22.00	Eukiefferiella.sp.
106.75	247.88	71.00	Prostoma.rubrum
106.78	480.50	87.00	Uncinais.uncinata
108.38	245.00	62.00	Pleurocera.acuta
108.67	612.86	18.00	Cricotopus.sp.
109.08	-9.00	2.00	Aeolosoma.sp.
110.00	204.76	31.00	Hydropsyche.sp.
125.38	4348.33	41.00	Nais.behningi
137.18	-9.00	72.00	Pseudocleon.sp.
148.97	461.43	69.00	Pristina.osborni
168.57	-9.00	29.00	Heterotrissocladius.sp.
189.52	2095.00	37.00	Lumbriculus.variegatus
223.18	-9.00	48.00	Paralauterborniella.sp.
311.24	-9.00	68.00	Pristina.foreli

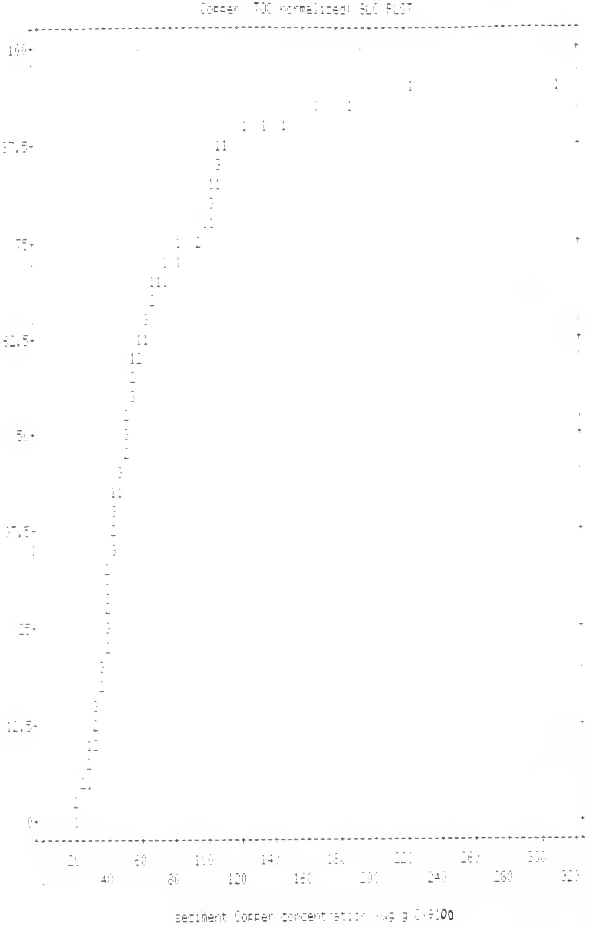


FIGURE E-4: SLC PLOT FOR COPPER

TABLE E-5: TOC Normalized Species SLC Values for
Fe ug/g C ÷100

P90	P95	SPNO	SPECIES
12677.74	25536.39	26.00	Glyptotendipes.sp.
13683.13	16993.68	96.00	Helobdella.stagnalis
17541.67	20533.33	35.00	Limnodrilus.sp.
19005.91	-9.00	17.00	Coelotanypus.sp.
19040.00	27510.00	4.00	Asellus.sp.
20200.00	27519.35	85.00	Tubifex.sp.
31600.00	-9.00	97.00	Hexagenia.limbata
33205.85	45110.00	65.00	Pontoporeia.hoyi
33402.89	58608.34	93.00	Chironomus.plumosus
34035.48	45090.91	59.00	Pisidium.lilljeborgi
35566.10	60013.53	27.00	Gyraulus.parvus
35681.82	-9.00	56.00	Pisidium.conventus
36674.64	-9.00	47.00	Parachironomus.sp.
36809.11	66517.36	70.00	Procladius.sp.
38814.82	94894.11	21.00	Dicrotendipes.sp.
41651.53	65641.67	100.00	Tubifex.tubifex
42173.91	90000.00	73.00	Quistadrilus.multisetosus
45544.83	-9.00	76.00	Sphaerium.nitidum
45625.43	783404.1	12.00	Chaetogaster.diaphanus
46639.39	88181.82	30.00	Hyalella.azteca
46753.73	54263.32	88.00	Valvata.sincera
47269.74	66041.67	34.00	Limnodrilus.hoffmeisteri
47368.41	1075714	7.00	Aulodrilus.pluriseta
47368.41	85714.29	14.00	Chironomus.sp.
47810.53	1025500	10.00	Caenis.sp.
49521.53	72541.66	1.00	Ablabesmyia.sp.
51282.45	-9.00	63.00	Polypedilum.scalaenum
52391.34	-9.00	40.00	Mystacides.sp.
52530.61	76951.94	20.00	Cryptochironomus.sp.
52800.00	92901.78	61.00	Pisidium.variabile
53922.08	136915.0	49.00	Paratendipes.sp.
59553.81	-9.00	9.00	Branchiura.sowerbyi
62964.53	77317.30	6.00	Aulodrilus.pigueti
64000.00	82321.43	16.00	Cladotanytarsus.sp.
65625.00	78538.39	75.00	Specaria.josinae
65591.35	77519.76	36.00	Limnodrilus.udekemianus
67565.41	82165.76	89.00	Valvata.tricarinata
68177.93	-9.00	33.00	Ilyodrilus.templetoni
69333.34	343335.0	66.00	Potamothrix.moldaviensis
70152.61	-9.00	28.00	Helisoma.anceps
70925.82	138696.8	15.00	Cladopelma.sp.
72330.53	199066.7	46.00	Oecetis.sp.
72330.53	149141.7	50.00	Phaenopsectra.sp.
74935.81	148205.3	55.00	Pisidium.compressum
79761.90	-9.00	39.00	Microtendipes.sp.
80165.79	1697143	60.00	Pisidium.nitidum
81454.54	93094.74	81.00	Stylaria.lacustris
81608.71	199450.5	23.00	Gammarus.fasciatus
82919.15	144494.0	54.00	Pisidium.casertanum
83025.11	166051.1	78.00	Spirosperma.fero
83361.34	135511.5	67.00	Potamothrix.vejdovskyi
84143.11	124550.3	52.00	Physella.gyrina
84369.74	184729.7	8.00	Bithynia.tentaculata
84705.88	106800.0	3.00	Amnicola.limosa
86831.30	102417.6	43.00	Nais.variabilis
86831.30	199487.1	84.00	Thienemannimyia.sp.
88544.89	211813.3	90.00	Vejdovskyella.interme
89915.97	174978.4	83.00	Tanytarsus.sp.
91304.34	149711.5	64.00	Polypedilum.sp.
91596.64	200625.0	58.00	Pisidium.henslowanu
91791.30	229133.3	51.00	Phallodrilus.sp.
94613.00	261904.8	22.00	Eukiefferiella.sp.
101809.8	-9.00	24.00	Glossiphonia.heterocl
105003.0	1393333	53.00	Piguetiella.michiganens
111925.5	1512857	5.00	Aulodrilus.limnobius
112857.1	265333.3	86.00	Turbellaria.sp.inter
119975.5	-9.00	72.00	Pseudocloeon.sp.
128914.3	317333.3	77.00	Sphaerium.striatium
130000.0	247476.2	13.00	Cheumatopsyche.sp.
130000.0	251166.7	82.00	Stylodrilus.heringian
132083.3	395056.9	71.00	Prostoma.rubrum
132083.3	255952.4	79.00	Stenonema.sp.
133234.0	-9.00	80.00	Stictochironomus.sp.
137983.2	212802.2	25.00	Glossosoma.sp.
141250.0	357708.3	57.00	Pisidium.fallax
143750.0	151849.6	45.00	Neureclipsis.sp.
144462.3	838461.6	74.00	Slavina.appendiculata
145856.7	2135000	42.00	Nais.communis
145903.6	602142.9	32.00	Hydroptila.sp.
145903.6	390738.6	62.00	Pleurocera.acuta
149001.1	245337.2	92.00	Sphaerium.simile
156794.0	697414.3	38.00	Manayunkia.speciosa
163736.3	990625.0	44.00	Nanocladius.sp.
184615.4	360416.7	31.00	Hydropsyche.sp.
205384.6	1245909	18.00	Cricotopus.sp.
208351.6	401515.1	11.00	Ceraclea.sp.
221027.0	-9.00	91.00	Elliptio.complanata
229130.8	1116670	41.00	Nais.behningi
250000.0	4930000	37.00	Lumbriculus.variegatu
297619.0	1846364	69.00	Pristina.osborni
306346.1	-9.00	2.00	Aeolosoma.sp.
354260.2	2014375	87.00	Uncinais.uncinata
536853.9	-9.00	29.00	Heterotrissocladius.sp
916363.6	-9.00	48.00	Paralauterborniella.sp
1318417	-9.00	68.00	Pristina.foreli

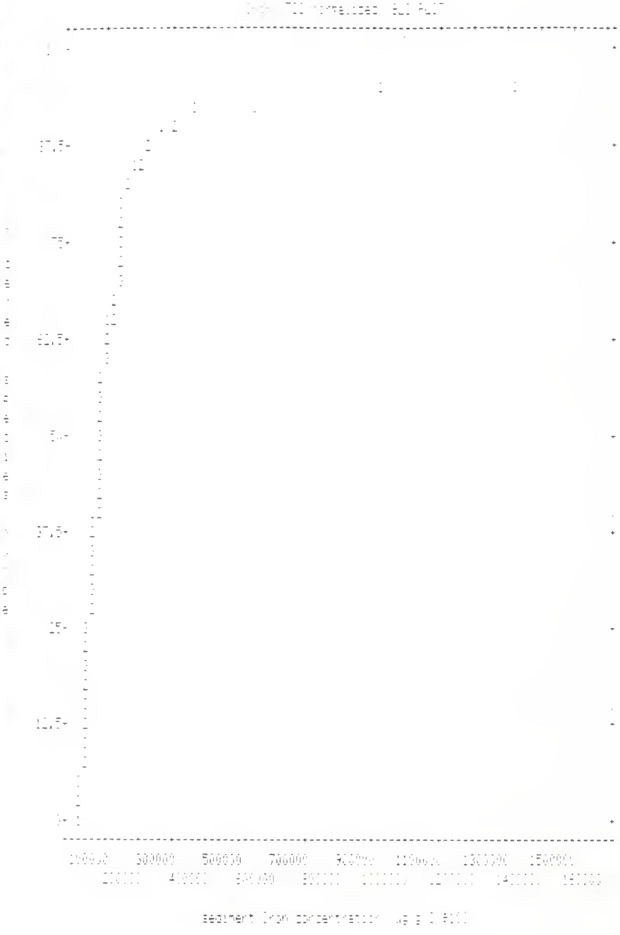


FIGURE E-5 SLC PLOT FOR IRON

TABLE B-6: TOC Normalized Species SLC values for
Pb ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
22.21	-9.00	9.00	Branchiura.sowerbyi
24.21	-9.00	59.00	Pisidium.lilljeborgi
29.16	-9.00	76.00	Sphaerium.nitidum
29.22	-9.00	17.00	Coelotanypus.sp.
29.43	37.35	65.00	Pontoporeia.hoyi
31.84	-9.00	80.00	Stictochironomus.sp.
38.16	-9.00	26.00	Glyptotendipes.sp.
41.50	-9.00	56.00	Pisidium.conventus
42.96	-9.00	63.00	Polypedilum.scalaenum
53.87	-9.00	28.00	Helisoma.anceps
59.58	63.56	21.00	Dicrotendipes.sp.
60.35	-9.00	91.00	Elliptio.complanata
60.74	-9.00	4.00	Asellus.sp.
60.74	-9.00	96.00	Helobdella.stagnalis
61.91	80.41	35.00	Limnodrilus.sp.
62.12	-9.00	24.00	Glossiphonia.heteroclita
63.46	86.01	14.00	Chironomus.sp.
63.54	152.79	85.00	Tubifex.sp.
63.71	101.17	70.00	Procladius.sp.
68.34	91.06	20.00	Cryptochironomus.sp.
68.65	1711.40	60.00	Pisidium.nitidum
69.03	206.86	1.00	Ablabesmyia.sp.
71.46	895.26	10.00	Caenis.sp.
71.46	95.69	89.00	Valvata.tricarinata
72.97	90.67	49.00	Paratendipes.sp.
73.09	-9.00	47.00	Parachironomus.sp.
74.05	-9.00	27.00	Gyraulus.parvus
76.00	169.23	83.00	Tanytarsus.sp.
77.46	140.31	46.00	Oecetis.sp.
77.80	89.08	88.00	Valvata.sincera
77.83	154.02	81.00	Stylaria.lacustris
78.26	233.00	75.00	Specaria.josinae
78.90	870.83	53.00	Piguetiella.michiganensis
80.34	200.03	45.00	Neureclipsis.sp.
80.65	328.21	6.00	Aulodrilus.pigueti
81.24	95.24	61.00	Pisidium.variabile
83.03	121.33	8.00	Bithynia.tentaculata
83.86	-9.00	39.00	Microtendipes.sp.
84.92	157.16	34.00	Limnodrilus.hoffmeisteri
85.38	226.50	50.00	Phaenopsectra.sp.
88.63	229.92	64.00	Polypedilum.sp.
89.95	325.19	55.00	Pisidium.compressum
93.79	178.40	84.00	Thienemannimyia.sp.
96.57	-9.00	93.00	Chironomus.plumosus
97.38	262.27	67.00	Potamothrix.vejdovskyi
98.41	1145.00	42.00	Nais.communis
100.04	-9.00	72.00	Pseudocloeon.sp.
103.60	600.33	92.00	Sphaerium.simile
110.86	1625.00	66.00	Potamothrix.moldaviensis
111.01	-9.00	33.00	Ilyodrilus.templetoni
111.33	154.22	52.00	Physella.gyrina
111.57	225.50	90.00	Vejdovskyella.intermedia
111.91	179.81	82.00	Stylodrilus.heringianus
115.43	371.74	23.00	Gammarus.fasciatus
115.67	343.66	54.00	Pisidium.casertanum
123.81	-9.00	36.00	Limnodrilus.udekemianus
124.64	434.38	78.00	Spirosperma.ferox
125.00	163.04	3.00	Amnicola.limosa
127.73	-9.00	73.00	Quistadrilus.multisetosus
128.61	699.38	58.00	Pisidium.henslowanum
131.66	202.46	16.00	Cladotanytarsus.sp.
137.03	943.47	12.00	Chaetogaster.diaphanus
137.84	400.61	77.00	Sphaerium.striatum
143.62	373.47	43.00	Nais.variabilis
151.01	475.84	57.00	Pisidium.fallax
151.94	448.46	74.00	Slavina.appendiculata
152.51	371.90	86.00	Turbellaria.sp.indet
152.94	228.41	30.00	Hyalella.azteca
154.02	596.36	62.00	Pleurocera.acuta
158.62	940.63	44.00	Nanocladius.sp.
161.85	291.60	25.00	Glossosoma.sp.
162.86	372.53	79.00	Stenonema.sp.
167.37	634.55	71.00	Prostoma.rubrum
167.99	326.95	22.00	Eukiefferiella.sp.
170.64	407.86	11.00	Ceraclea.sp.
173.46	400.21	13.00	Cheumatopsyche.sp.
192.79	480.71	32.00	Hydroptila.sp.
217.52	1794.05	41.00	Nais.behningi
236.36	767.27	18.00	Cricotopus.sp.
252.51	362.98	51.00	Phallodrilus.sp.
258.57	1400.00	37.00	Lumbriculus.variegatus
261.32	1674.92	7.00	Aulodrilus.pleuriseta
305.03	-9.00	15.00	Cladopelma.sp.
305.03	648.13	38.00	Manayunkia.speciosa
316.01	1563.64	5.00	Aulodrilus.limnobius
326.95	1130.00	31.00	Hydropsyche.sp.
349.19	1781.82	69.00	Pristina.osborni
627.47	-9.00	29.00	Heterotrissocladius.sp.
750.68	-9.00	2.00	Aeolosoma.sp.
887.50	-9.00	87.00	Uncinais.uncinata
1024.75	-9.00	48.00	Paralauterborniella.sp.
1319.92	-9.00	68.00	Pristina.foreli

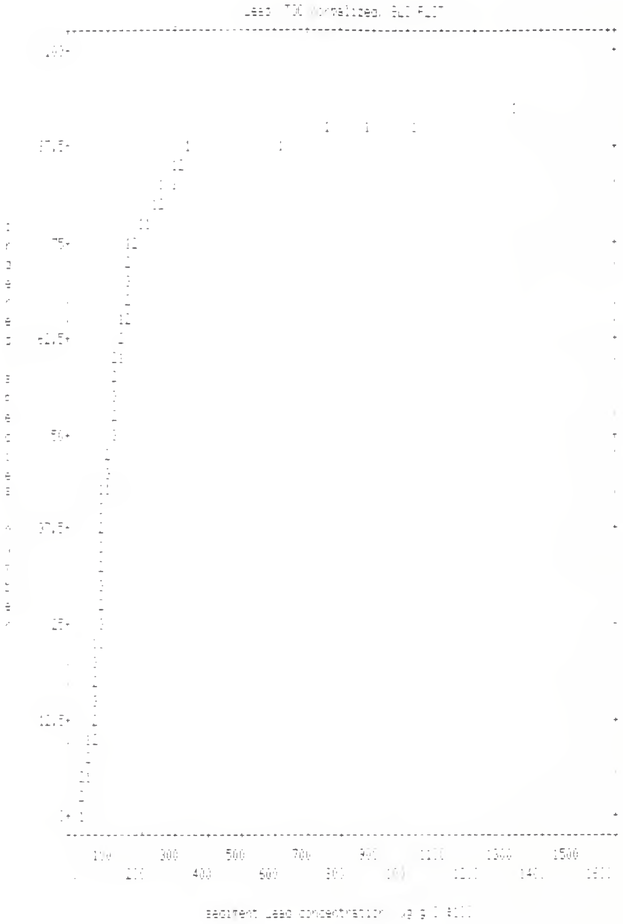


FIGURE E-6 SLC PLOT FOR LEAD

TABLE E-7: TOC Normalized Species SLC Values for Mn (ug/g C)÷100

P90	P95	SPNO	SPECIES
265.54	303.89	70.00	Procladius.sp.
289.33	359.68	35.00	Limnodrilus.sp.
291.17	475.77	85.00	Tubifex.sp.
323.05	988.57	23.00	Gammarus.fasciatus
335.50	361.66	64.00	Polypedilum.sp.
359.56	-9.00	46.00	Oecetis.sp.
362.42	-9.00	4.00	Asellus.sp.
362.42	-9.00	96.00	Helobdella.stagnalis
367.50	-9.00	9.00	Branchiura.sowerbyi
480.09	-9.00	20.00	Cryptochironomus.sp.
491.78	-9.00	93.00	Chironomus.plumosus
615.92	1088.82	14.00	Chironomus.sp.
5465.24	6636.36	30.00	Hyalella.azteca
6636.36	-9.00	18.00	Cricotopus.sp.

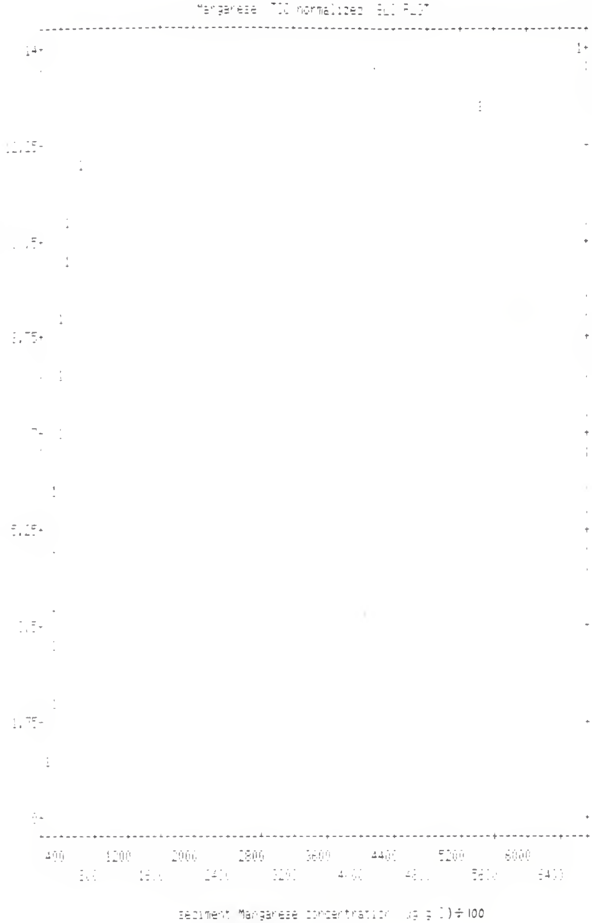


FIGURE E-7: SLC PLOT FOR MANGANESE

TABLE E-8: TOC Normalized Species SLC Values for
Hg ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
.07	-9.00	63.00	Polypedilum.scalaenum
.10	-9.00	56.00	Pisidium.conventus
.11	.31	92.00	Sphaerium.simile
.11	.19	26.00	Glyptotendipes.sp.
.13	.18	93.00	Chironomus.plumosus
.13	-9.00	9.00	Branchiura.sowerbyi
.14	-9.00	91.00	Elliptio.complanata
.16	.20	65.00	Pontoporeia.hoyi
.20	.36	61.00	Pisidium.variabile
.21	3.63	96.00	Helobdella.stagnalis
.21	.42	100.00	Tubifex.tubifex
.24	-9.00	76.00	Sphaerium.nitidum
.25	.43	85.00	Tubifex.sp.
.30	.60	4.00	Asellus.sp.
.32	.71	59.00	Pisidium.lilljeborgi
.33	.49	30.00	Hyalella.azteca
.35	.38	35.00	Limnodrilus.sp.
.42	-9.00	17.00	Coelotanypus.sp.
.44	1.47	45.00	Neureclipsis.sp.
.45	.79	70.00	Procladius.sp.
.46	1.13	84.00	Thienemannimyia.sp.
.47	.91	22.00	Eukiefferiella.sp.
.47	1.41	8.00	Bithynia.tentaculata
.48	6.08	12.00	Chaetogaster.diaphanus
.49	.68	20.00	Cryptochironomus.sp.
.49	12.90	60.00	Pisidium.nitidum
.49	2.07	90.00	Vejdovskyella.intermedia
.50	1.57	49.00	Paratendipes.sp.
.50	.75	55.00	Pisidium.compressum
.51	1.25	25.00	Glossosoma.sp.
.51	.58	50.00	Phaenopsectra.sp.
.52	.74	34.00	Limnodrilus.hoffmeisteri
.54	1.25	58.00	Pisidium.henslowanum
.55	1.22	14.00	Chironomus.sp.
.56	1.25	54.00	Pisidium.casertanum
.56	1.64	52.00	Physella.gyrina
.56	.92	32.00	Stylodrilus.heringianus
.58	1.24	73.00	Quistadrilus.multisetosus
.59	4.13	41.00	Nais.behningi
.59	1.25	64.00	Polypedilum.sp.
.60	1.15	83.00	Tanytarsus.sp.
.62	1.50	89.00	Valvata.tricarinata
.63	1.71	1.00	Ablabesmyia.sp.
.64	1.71	78.00	Spirosperma.ferox
.64	1.54	79.00	Stenonema.sp.
.67	1.48	27.00	Gyraulus.parvus
.68	1.28	13.00	Cheumatopsyche.sp.
.69	1.00	81.00	Stylaria.lacustris
.69	1.51	23.00	Gammarus.fasciatus
.69	3.99	66.00	Potamothrix.moldaviensis
.69	1.22	31.00	Hydropsyche.sp.
.72	1.20	16.00	Cladotanytarsus.sp.
.72	.95	51.00	Phallodrilus.sp.
.73	1.57	71.00	Prostoma.rubrum
.73	1.14	88.00	Valvata.sincera
.74	5.50	7.00	Aulodrilus.pleuriseta
.74	9.20	75.00	Specaria.josinae
.74	-9.00	2.00	Aeolosoma.sp.
.78	1.31	3.00	Amnicola.limosa
.79	-9.00	72.00	Pseudocleon.sp.
.79	1.41	77.00	Sphaerium.striatium
.80	1.96	46.00	Oecetis.sp.
.88	-9.00	87.00	Uncinais.uncinata
.91	3.16	67.00	Potamothrix.vejdovskyi
.92	6.91	6.00	Aulodrilus.piqueti
.93	1.75	62.00	Pleurocera.acuta
.95	-9.00	28.00	Helisoma.anceps
.98	10.22	36.00	Limnodrilus.udekemianus
.99	2.43	57.00	Pisidium.fallax
1.00	2.14	86.00	Turbellaria.sp.indet
1.01	11.63	5.00	Aulodrilus.limnobius
1.02	11.10	53.00	Piguetiella.michiganensis
1.02	-9.00	47.00	Parachironomus.sp.
1.08	1.89	43.00	Nais.variabilis
1.13	1.57	44.00	Nanocladius.sp.
1.16	-9.00	97.00	Hexagenia.limbata
1.20	1.99	11.00	Ceraclea.sp.
1.20	15.79	15.00	Cladopelma.sp.
1.27	2.33	18.00	Cricotopus.sp.
1.29	2.70	42.00	Nais.communis
1.33	2.60	37.00	Lumbriculus.variegatus
1.41	4.31	32.00	Hydroptila.sp.
1.48	3.78	38.00	Manayunkia.speciosa
1.56	5.85	74.00	Slavina.appendiculata
1.57	5.54	69.00	Pristina.osborni
1.57	4.07	21.00	Dicrotendipes.sp.
1.70	1.97	10.00	Caenis.sp.
2.35	-9.00	24.00	Glossiphonia.heteroclita
2.49	-9.00	39.00	Microtendipes.sp.
2.60	-9.00	80.00	Stictochironomus.sp.
4.55	-9.00	29.00	Heterotrissocladius.sp.
6.10	-9.00	33.00	Ilyodrilus.templetoni
8.17	-9.00	48.00	Paralauterborniella.sp.
10.27	-9.00	68.00	Pristina.foreli
12.75	-9.00	40.00	Mystacides.sp.

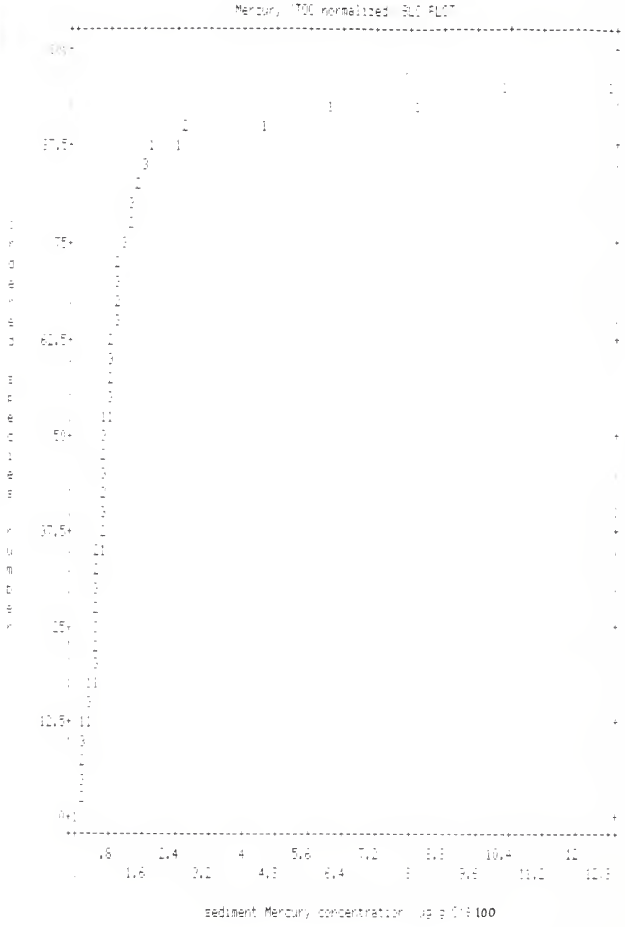


FIGURE E-8: SLC PLOT FOR MERCURY

TABLE E-9: TOC Normalized Species SLC Values for
Ni ((ug/g C)*100)

P90	P95	SPNO	SPECIES
15.91	-9.00	59.00	Pisidium.lilljeborgi
20.42	-9.00	17.00	Coelotanypus.sp.
21.58	-9.00	47.00	Parachironomus.sp.
21.99	-9.00	56.00	Pisidium.conventus
23.97	53.01	35.00	Limnodrilus.sp.
24.40	31.08	61.00	Pisidium.variabile
26.30	61.63	85.00	Tubifex.sp.
27.42	105.47	65.00	Pontoporeia.hoyi
29.02	-9.00	80.00	Stictochironomus.sp.
35.40	-9.00	28.00	Helisoma.anceps
37.89	200.15	75.00	Specaria.josinae
37.93	339.68	21.00	Dicrotendipes.sp.
37.99	44.08	70.00	Procladius.sp.
38.20	-9.00	63.00	Polypedilum.scalaenum
38.26	-9.00	27.00	Gyraulus.parvus
38.76	185.13	46.00	Oecetis.sp.
39.80	169.06	6.00	Aulodrilus.pigueti
41.09	116.88	34.00	Limnodrilus.hoffmeisteri
41.45	-9.00	76.00	Sphaerium.nitidum
42.08	75.27	50.00	Phaenopsectra.sp.
42.68	486.92	12.00	Chaetogaster.diaphanus
42.75	63.65	1.00	Ablabesmyia.sp.
42.96	936.95	7.00	Aulodrilus.pleuriseta
42.96	2888.95	10.00	Caenis.sp.
42.96	53.09	89.00	Valvata.tricarinata
43.09	67.40	20.00	Cryptochironomus.sp.
44.83	47.37	88.00	Valvata.sincera
47.02	81.35	49.00	Paratendipes.sp.
52.82	120.00	16.00	Cladotanytarsus.sp.
54.07	175.38	22.00	Eukiefferiella.sp.
54.07	-9.00	9.00	Branchiura.sowerbyi
57.05	-9.00	4.00	Asellus.sp.
57.05	82.35	81.00	Stylaria.lacustris
57.05	-9.00	96.00	Helobdella.stagnalis
59.87	-9.00	73.00	Quistadrilus.multisetosus
61.82	83.09	52.00	Physella.gyrina
63.81	95.59	51.00	Phallodrilus.sp.
66.46	966.18	66.00	Potamothrix.moldaviensis
67.45	127.30	54.00	Pisidium.casertanum
67.78	-9.00	55.00	Pisidium.compressum
68.03	97.47	14.00	Chironomus.sp.
69.02	147.69	3.00	Amnicola.limosa
70.20	100.00	64.00	Polypedilum.sp.
70.59	190.91	78.00	Spirosperma.ferox
74.56	510.63	58.00	Pisidium.henslowanum
76.35	229.09	23.00	Gammarus.fasciatus
77.10	230.00	84.00	Thienemannimyia.sp.
78.12	144.42	90.00	Vejdovskyella.intermedia
79.79	99.62	25.00	Glossosoma.sp.
80.50	475.00	71.00	Prostoma.rubrum
80.50	188.96	79.00	Stenonema.sp.
82.35	841.00	5.00	Aulodrilus.limnobius
83.45	1001.00	60.00	Pisidium.nitidum
84.83	150.00	67.00	Potamothrix.vejdovskyi
85.69	154.79	13.00	Cheumatopsyche.sp.
85.69	207.27	86.00	Turbellaria.sp.indet
85.89	274.68	43.00	Nais.variabilis
86.52	333.33	57.00	Pisidium.fallax
86.67	172.73	8.00	Bithynia.tentaculata
87.58	-9.00	39.00	Microtendipes.sp.
87.75	1282.00	42.00	Nais.communis
88.20	261.82	77.00	Sphaerium.striatium
90.67	-9.00	72.00	Pseudocleon.sp.
93.08	137.71	82.00	Stylodrilus.heringianus
94.62	104.38	45.00	Neureclipsis.sp.
95.38	312.73	62.00	Pleurocera.acuta
95.38	163.33	83.00	Tanytarsus.sp.
95.99	374.00	11.00	Ceraclea.sp.
96.92	1328.89	74.00	Slavina.appendiculata
96.95	842.22	32.00	Hydroptila.sp.
100.00	-9.00	36.00	Limnodrilus.udekemianus
100.00	1659.38	44.00	Nanocladius.sp.
102.92	916.88	38.00	Manayunkia.speciosa
118.17	-9.00	93.00	Chironomus.plumosus
151.81	-9.00	15.00	Cladopelma.sp.
160.00	1262.00	41.00	Nais.behningi
169.06	-9.00	33.00	Ilyodrilus.templetoni
172.39	1031.00	69.00	Pristina.osborni
175.38	1166.00	31.00	Hydropsyche.sp.
176.36	875.64	18.00	Cricotopus.sp.
180.00	2144.00	37.00	Lumbriculus.variegatus
200.00	958.89	53.00	Piguetiella.michiganensis
243.85	282.27	30.00	Hyalella.azteca
418.00	-9.00	29.00	Heterotrissocladius.sp.
578.55	-9.00	48.00	Paralauterborniella.sp.
644.42	-9.00	2.00	Aeolosoma.sp.
729.26	-9.00	68.00	Pristina.foreli
1012.50	-9.00	87.00	Uncinais.uncinata

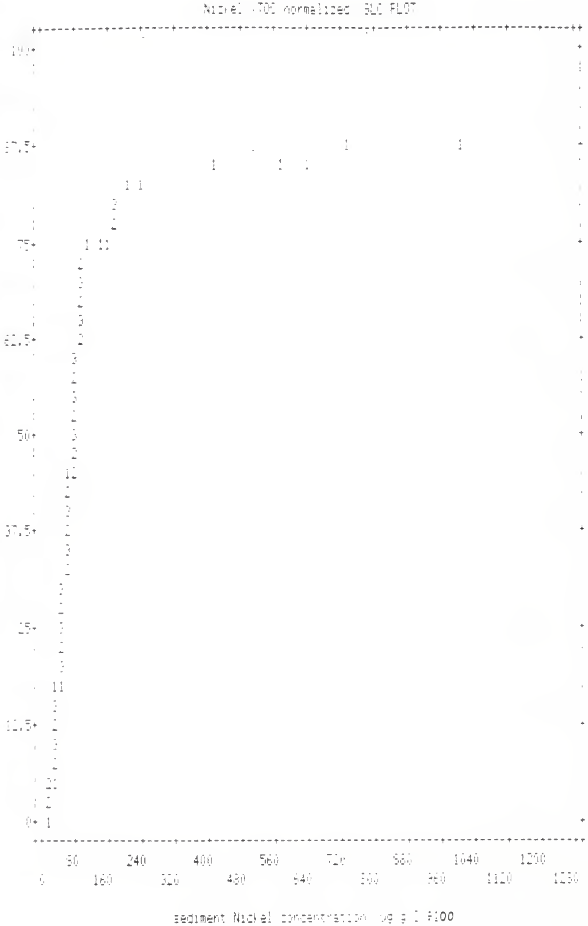


FIGURE E-9: SLC PLOT FOR NICKEL

TABLE E-10: TIC Normalized Species SLC Values for
Zn ((ug/g C)÷100)

P90	P95	SPNO	SPECIES
65.71	642.86	26.00	Glyptotendipes.sp.
103.64	-9.00	17.00	Coelotanypus.sp.
122.37	128.38	59.00	Pisidium.lilljeborgi
126.03	268.46	4.00	Asellus.sp.
139.62	-9.00	56.00	Pisidium.conventus
141.03	-9.00	24.00	Glossiphonia.heteroclita
148.00	-9.00	97.00	Hexagenia.limbata
149.49	198.00	65.00	Pontoporeia.hoyi
156.61	-9.00	63.00	Polypedilum.scalaenum
161.36	-9.00	80.00	Stictochironomus.sp.
162.58	-9.00	76.00	Sphaerium.nitidum
165.87	222.68	61.00	Pisidium.variabile
175.07	279.83	85.00	Tubifex.sp.
176.36	494.87	35.00	Limnodrilus.sp.
181.39	429.94	93.00	Chironomus.plumosus
183.09	-9.00	47.00	Parachironomus.sp.
183.44	269.41	100.00	Tubifex.tubifex
183.95	195.27	92.00	Sphaerium.simile
187.46	397.20	70.00	Procladius.sp.
188.83	411.43	1.00	Ablabesmyia.sp.
188.89	5085.71	7.00	Aulodrilus.pleuriseta
189.29	369.36	21.00	Dicrotendipes.sp.
190.48	570.18	14.00	Chironomus.sp.
193.94	307.10	34.00	Limnodrilus.hoffmeisteri
194.26	-9.00	91.00	Elliptio.complanata
198.16	3618.16	12.00	Chaetogaster.diaphanus
199.48	363.75	98.00	Valvata.sincera
205.24	347.24	89.00	Valvata.tricarinata
222.22	438.10	73.00	Quistadrilus.multisetosus
223.51	268.46	96.00	Helobdella.stagnalis
235.22	422.99	55.00	Pisidium.compressum
256.43	425.60	8.00	Bithynia.tentaculata
256.95	7900.47	60.00	Pisidium.nitidum
272.80	380.00	20.00	Cryptochironomus.sp.
273.16	-9.00	9.00	Branchiura.sowerbyi
284.36	-9.00	28.00	Helisoma.anceps
289.76	494.92	78.00	Spirosperma.ferox
290.76	372.86	50.00	Phaenopsectra.sp.
293.90	478.57	36.00	Limnodrilus.udekemianus
294.45	1757.89	27.00	Gyraulus.parvus
296.02	385.00	81.00	Stylaria.lacustris
298.90	479.43	3.00	Amnicola.limosa
331.08	651.56	83.00	Tanytarsus.sp.
333.45	787.27	90.00	Vejdovskyella.intermedia
365.31	1108.96	52.00	Physella.gyrina
368.05	596.55	58.00	Pisidium.henslowanum
370.93	4130.71	10.00	Caenis.sp.
371.43	477.70	75.00	Soecaria.josinae
371.79	1072.50	54.00	Pisidium.casertanum
373.03	476.55	6.00	Aulodrilus.pigueti
373.21	975.49	66.00	Potamothrix.moldaviensis
379.46	473.33	15.00	Cladopelma.sp.
391.82	1474.57	46.00	Oecetis.sp.
394.18	-9.00	40.00	Mystacides.sp.
400.00	1122.38	23.00	Gammarus.fasciatus
402.19	470.50	51.00	Phallodrilus.sp.
402.34	-9.00	33.00	Ilyodrilus.templetoni
428.74	7057.14	5.00	Aulodrilus.limnobius
460.44	-9.00	39.00	Microtendipes.sp.
480.38	1509.05	64.00	Polypedilum.sp.
494.23	1303.81	16.00	Cladotanytarsus.sp.
522.10	1255.84	67.00	Potamothrix.vejdovskyi
577.66	1130.06	49.00	Paratendipes.sp.
597.06	1272.73	30.00	Hyalella.azteca
632.01	5770.91	38.00	Manayunkia.speciosa
637.59	1320.39	45.00	Neureclipsis.sp.
643.18	3265.39	74.00	Slavina.appendiculata
786.60	2278.33	43.00	Nais.variabilis
792.71	9610.00	42.00	Nais.communis
821.88	3837.44	32.00	Hydroptila.sp.
853.57	3265.39	44.00	Nanocladius.sp.
932.14	1698.33	82.00	Stylodrilus.heringianus
1050.00	-9.00	87.00	Uncinais.uncinata
1074.55	1402.67	77.00	Sphaerium.striatium
1086.92	2223.63	57.00	Pisidium.fallax
1109.79	2201.53	86.00	Turbellaria.sp.indet
1112.31	-9.00	2.00	Aeolosoma.sp.
1122.69	2076.91	13.00	Cheumatopsyche.sp.
1134.96	2458.88	71.00	Prostoma.rubrum
1153.85	1352.38	31.00	Hydropsyche.sp.
1163.41	2347.61	62.00	Pleurocera.acuta
1254.29	2219.95	22.00	Eukiefferiella.sp.
1260.00	2347.61	84.00	Thienemannimyia.sp.
1272.73	5193.33	18.00	Cricotopus.sp.
1384.76	2458.88	79.00	Stenonema.sp.
1400.95	2764.88	11.00	Ceraclea.sp.
1417.14	2260.47	25.00	Glossosoma.sp.
1660.48	7227.18	53.00	Piguetiella.michiganensis
2014.91	8753.08	69.00	Pristina.osborni
2212.58	7422.45	41.00	Nais.behningi
2431.06	9690.00	37.00	Lumbriculus.variegatus
2485.71	-9.00	29.00	Heterotrissocladius.sp.
2542.33	-9.00	72.00	Pseudocleon.sp.
5234.29	-9.00	48.00	Paralauterborniella.sp.
6131.69	-9.00	68.00	Pristina.foreli

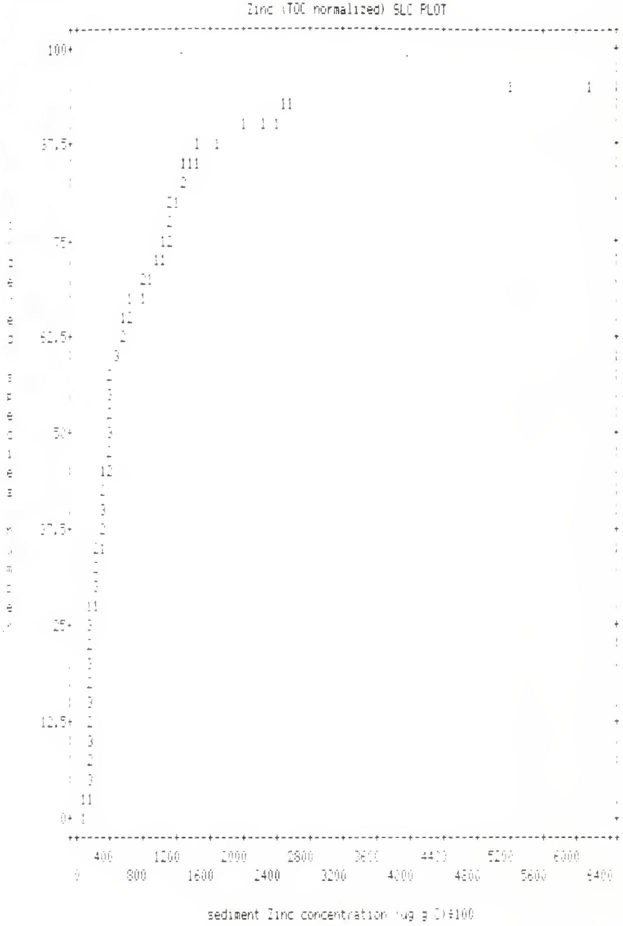


FIGURE E-10: SLC PLOT FOR ZINC

TABLE E-23: TOC Normalized Species SLC Values for PCBs ((ug/g C)*100)

P90	P95	SPNO	SPECIES
.06	.06	39.00	Microtendipes.sp.
.06	.14	17.00	Coelotanypus.sp.
.06	.11	26.00	Glyptotendipes.sp.
.06	.10	96.00	Helobdella.stagnalis
.08	.13	30.00	Hyalella.azteca
.08	.15	93.00	Chironomus.plumosus
.08	.58	9.00	Branchiura.sowerbyi
.10	.22	8.00	Bithynia.tentaculata
.14	.49	4.00	Asellus.sp.
.15	.29	46.00	Oecetis.sp.
.15	.35	89.00	Valvata.tricarinata
.16	.25	65.00	Pontoporeia.hoyi
.16	-9.00	76.00	Sphaerium.nitidum
.16	-9.00	47.00	Parachironomus.sp.
.17	-9.00	63.00	Polypedilum.scalaenum
.18	.23	27.00	Gyraulus.parvus
.20	-9.00	56.00	Pisidium.conventus
.20	.30	83.00	Tanytarsus.sp.
.20	.36	100.00	Tubifex.tubifex
.20	.23	21.00	Dicrotendipes.sp.
.21	.30	20.00	Cryptochironomus.sp.
.21	-9.00	28.00	Helisoma.anceps
.22	.57	88.00	Valvata.sincera
.22	.96	90.00	Vejdovskyella.intermedia
.22	1.25	66.00	Potamothrix.moldaviensis
.22	.32	34.00	Limnodrilus.hoffmeisteri
.22	.37	73.00	Quistadrilus.multisetosus
.22	.25	10.00	Caenis.sp.
.22	.38	14.00	Chironomus.sp.
.22	.48	3.00	Amnicola.limosa
.22	.66	36.00	Limnodrilus.udekemianus
.23	.38	61.00	PPisidium.variabile
.24	.72	54.00	Pisidium.casertanum
.28	.54	64.00	Polypedilum.sp.
.29	.55	70.00	Procladius.sp.
.29	-9.00	80.00	Stictochironomus.sp.
.29	.44	58.00	Pisidium.henslowanum
.29	12.80	60.00	Pisidium.nitidum
.29	.92	59.00	Pisidium.lilljeborgi
.29	-9.00	49.00	Paratendipes.sp.
.30	1.50	77.00	Sphaerium.striatium
.30	.83	81.00	Stylaria.lacustris
.30	.96	67.00	Potamothrix.vejdovskyi
.31	.89	94.00	Thienemannimyia.sp.
.31	14.27	42.00	Nais.communis
.31	.34	74.00	Slavina.appendiculata
.32	.96	6.00	Aulodrilus.piqueti
.32	7.66	53.00	Piguetiella.michiganensis
.33	.44	23.00	Gammarus.fasciatus
.33	.42	52.00	Physella.gyrina
.35	.57	35.00	Limnodrilus.sp.
.35	-9.00	55.00	Pisidium.compressum
.35	1.12	16.00	Cladotanytarsus.sp.
.38	.60	18.00	Cricotopus.sp.
.38	14.27	87.00	Uncinais.uncinata
.39	.94	78.00	Spirosperma.ferox
.42	4.56	38.00	Manayunkia.speciosa
.42	6.72	43.00	Nais.variabilis
.43	.56	1.00	Ablabesmyia.sp.
.43	1.31	82.00	Stylodrilus.heringianus
.45	5.01	57.00	Pisidium.fallax
.45	1.00	85.00	Tubifex.sp.
.46	-9.00	33.00	Ilyodrilus.templetoni
.46	1.01	75.00	Specaria.josinae
.48	-9.00	32.00	Hydroptila.sp.
.52	.69	50.00	Phaenopsectra.sp.
.56	9.48	7.00	Aulodrilus.pleuriseta
.63	1.48	97.00	Hexagenia.limbata
.72	-9.00	15.00	Cladopelma.sp.
.82	21.48	25.00	Glossosoma.sp.
.82	22.76	31.00	Hydropsyche.sp.
1.07	7.60	86.00	Turbellaria.sp.indet
1.11	10.57	71.00	Prostoma.rubrum
1.15	12.35	13.00	Cheumatopsyche.sp.
1.36	9.53	12.00	Chaetogaster.diaphanus
2.85	-9.00	11.00	Ceraclea.sp.
5.76	22.12	62.00	Pleurocera.acuta
6.43	-9.00	5.00	Aulodrilus.limnobius
6.59	-9.00	69.00	Pristina.osborni
7.09	-9.00	29.00	Heterotrissocladius.sp.
9.98	-9.00	22.00	Eukiefferiella.sp.
10.86	-9.00	48.00	Paralauterborniella.sp.
11.36	-9.00	79.00	Stenonema.sp.
12.35	-9.00	44.00	Nanocladius.sp.

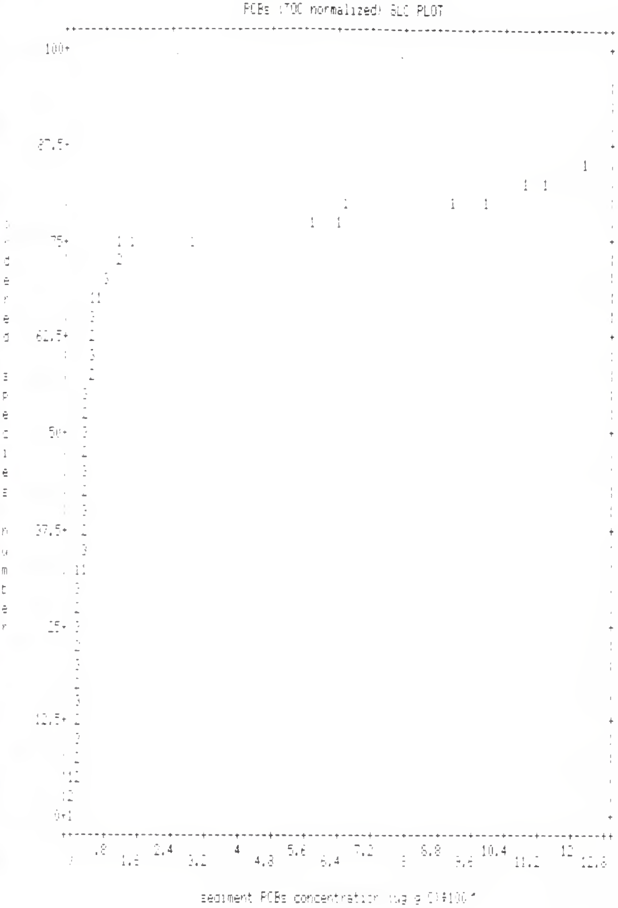


FIGURE E-23: SLC PLOT FOR PCBs

TABLE E-33: Species SLC Values for
TOC (%)

P90	P95	SPNO	SPECIES
.57	-9.00	63.00	Polypedilum.scalaenum
.59	1.05	87.00	Uncinais.uncinata
.91	-9.00	22.00	Eukiefferiella.sp.
.92	1.16	53.00	Piguetiella.michiganensis
1.02	-9.00	79.00	Stenonema.sp.
1.07	-9.00	40.00	Mystacides.sp.
1.13	-9.00	44.00	Nanocladius.sp.
1.18	3.75	62.00	Pleurocera.acuta
1.20	-9.00	11.00	Ceraclea.sp.
1.22	-9.00	42.00	Nais.communis
1.31	-9.00	48.00	Paralauterborniella.sp.
1.38	-9.00	32.00	Hydroptila.sp.
1.40	3.15	71.00	Prostoma.rubrum
1.43	1.67	12.00	Chaetogaster.diaphanus
1.50	2.40	43.00	Nais.variabilis
1.69	5.24	81.00	Stylaria.lacustris
1.77	2.43	86.00	Turbellaria.sp.indet
1.78	-9.00	74.00	Slavina.appendiculata
1.78	-9.00	69.00	Pristina.osborni
2.09	3.47	16.00	Cladotanytarsus.sp.
2.10	3.66	82.00	Stylodrilus.heringianus
2.14	2.47	6.00	Aulodrilus.piqueti
2.16	5.79	57.00	Pisidium.fallax
2.21	2.49	92.00	Sphaerium.simile
2.22	4.73	90.00	Vejdovskyella.intermedia
2.44	-9.00	37.00	Lumbriculus.variegatus
2.45	6.29	55.00	Pisidium.compressum
2.46	7.50	13.00	Cheumatopsyche.sp.
2.46	-9.00	28.00	Helisoma.anceps
2.61	-9.00	15.00	Cladopelma.sp.
2.62	-9.00	60.00	Pisidium.nitidum
2.78	4.42	31.00	Hydropsyche.sp.
2.87	7.08	67.00	Potamothrix.vejdovskyi
3.06	6.86	75.00	Specaria.josinae
3.08	-9.00	91.00	Elliptio.complanata
3.12	5.65	65.00	Pontoporeia.hoyi
3.55	5.77	61.00	Pisidium.variabile
3.91	-9.00	56.00	Pisidium.conventus
3.93	4.63	52.00	Physella.gyrina
3.96	-9.00	33.00	Ilyodrilus.templetoni
4.00	-9.00	97.00	Hexagenia.limbata
4.02	7.64	64.00	Polypedilum.sp.
4.16	10.05	78.00	Spirosperma.ferox
4.18	7.48	58.00	Pisidium.henslowanum
4.26	4.94	50.00	Phaenopsectra.sp.
4.27	7.31	10.00	Caenis.sp.
4.43	7.64	23.00	Gammarus.fasciatus
4.50	5.10	54.00	Pisidium.casertanum
4.58	-9.00	29.00	Heterotrissocladius.sp.
4.67	9.39	66.00	Potamothrix.moldaviensis
4.70	-9.00	49.00	Paratendipes.sp.
4.70	-9.00	76.00	Sphaerium.nitidum
4.71	6.12	83.00	Tanytarsus.sp.
4.71	-9.00	24.00	Glossiphonia.heteroclita
4.72	19.30	1.00	Ablabesmyia.sp.
4.72	-9.00	25.00	Glossosoma.sp.
4.86	6.61	3.00	Amnicola.limosa
4.87	7.43	85.00	Tubifex.sp.
4.90	6.22	88.00	Valvata.sincera
5.01	6.62	77.00	Sphaerium.striatium
5.41	7.74	8.00	Bithynia.tentaculata
5.56	-9.00	5.00	Aulodrilus.limnobius
5.58	8.35	34.00	Limnodrilus.hoffmeisteri
5.60	-9.00	47.00	Parachironomus.sp.
6.04	11.94	73.00	Quistadrilus.multisetosus
6.29	8.24	7.00	Aulodrilus.pleuriseta
6.37	8.99	38.00	Manayunkia.speciosa
6.42	7.80	59.00	Pisidium.lilljeborgi
6.43	8.96	93.00	Chironomus.plumosus
6.44	11.16	84.00	Thienemannimyia.sp.
6.65	11.68	100.00	Tubifex.tubifex
6.71	8.49	89.00	Valvata.tricarinata
7.06	7.85	18.00	Cricotopus.sp.
7.24	10.80	70.00	Procladius.sp.
7.24	8.36	27.00	Gyraulus.parvus
7.39	12.31	20.00	Cryptochironomus.sp.
7.59	9.74	35.00	Limnodrilus.sp.
7.84	8.70	30.00	Hyalella.azteca
8.22	10.01	4.00	Asellus.sp.
8.80	9.74	21.00	Dicrotendipes.sp.
8.91	9.59	26.00	Glyptotendipes.sp.
8.98	11.91	14.00	Chironomus.sp.
9.74	10.12	46.00	Oecetis.sp.
9.90	12.02	96.00	Helobdella.stagnalis
10.09	23.09	36.00	Limnodrilus.udekemianus
10.27	-9.00	39.00	Microtendipes.sp.
12.17	-9.00	9.00	Branchiura.sowerbyi
20.22	-9.00	17.00	Coelotanypus.sp.
22.84	-9.00	80.00	Stictochironomus.sp.

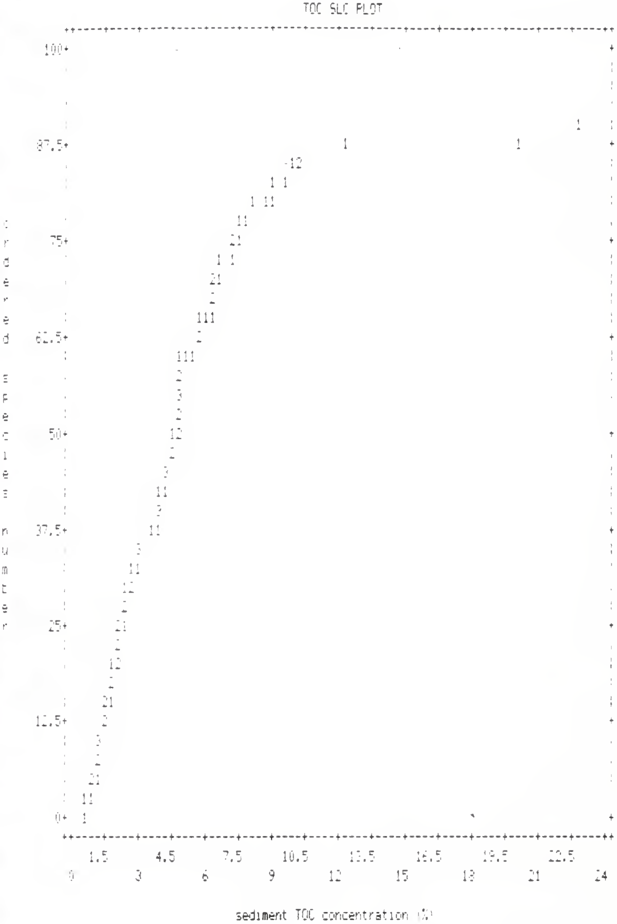


FIGURE E-33: SLC PLOT FOR TOC

TABLE E-34: Species SLC Values for
TKN (ug/g)

P90	P95	SPNO	SPECIES
256.00	-9.00	63.00	Polypedilum.scalaenum
296.00	775.00	87.00	Uncinais.uncinata
500.00	850.00	53.00	Piguetiella.michiganensis
540.00	-9.00	79.00	Stenonema.sp.
550.00	1800.00	62.00	Pleurocera.acuta
630.00	-9.00	22.00	Eukiefferiella.sp.
740.00	-9.00	44.00	Nanocladius.sp.
770.00	1600.00	12.00	Chaetogaster.diaphanus
780.00	1370.00	42.00	Nais.communis
800.00	-9.00	11.00	Ceraclea.sp.
880.00	-9.00	40.00	Mystacides.sp.
898.00	-9.00	37.00	Lumbriculus.variegatus
900.00	2125.00	71.00	Prostoma.rubrum
920.00	-9.00	69.00	Pristina.osborni
980.00	1370.00	81.00	Stylaria.lacustris
1000.00	1587.50	82.00	Stylodrilus.heringianus
1080.00	1740.00	43.00	Nais.variabilis
1100.00	-9.00	60.00	Pisidium.nitidum
1130.00	-9.00	32.00	Hydroptila.sp.
1160.00	1680.00	57.00	Pisidium.fallax
1160.00	1570.00	86.00	Turbellaria.sp.indet
1250.00	2225.00	16.00	Cladotanytarsus.sp.
1300.00	-9.00	48.00	Paralauterborniella.sp.
1300.00	2250.00	92.00	Sphaerium.simile
1300.00	-9.00	97.00	Hexagenia.limbata
1340.00	4390.00	31.00	Hydropsyche.sp.
1500.00	2100.00	6.00	Aulodrilus.pigueti
1660.00	2250.00	74.00	Slavina.appendiculata
1810.00	2255.00	78.00	Spirosperma.ferox
1870.00	-9.00	9.00	Branchiura.sowerbyi
1880.00	2960.00	67.00	Potamothrix.vejdovskyi
1880.00	4660.00	75.00	Specaria.josinae
1890.00	3015.00	90.00	Vejdovskyella.intermedia
1900.00	-9.00	15.00	Cladopelma.sp.
1900.00	-9.00	28.00	Helisoma.anceps
1900.00	2910.00	64.00	Polypedilum.sp.
2040.00	4060.00	66.00	Potamothrix.moldaviensis
2100.00	3900.00	38.00	Manayunkia.speciosa
2100.00	4560.00	55.00	Pisidium.compressum
2120.00	4900.00	36.00	Limnodrilus.udekemianus
2140.00	-9.00	33.00	Ilyodrilus.templetoni
2240.00	2940.00	1.00	Ablabesmyia.sp.
2340.00	4340.00	84.00	Thienemannimyia.sp.
2380.00	3940.00	23.00	Gammarus.fasciatus
2380.00	3060.00	50.00	Phaenopsectra.sp.
2400.00	-9.00	29.00	Heterotrissocladius.sp.
2440.00	3540.00	13.00	Cheumatopsyche.sp.
2480.00	3600.00	54.00	Pisidium.casertanum
2480.00	6990.00	100.00	Tubifex.tubifex
2500.00	5540.00	65.00	Pontoporeia.hoyi
2520.00	3600.00	34.00	Limnodrilus.hoffmeisteri
2540.00	3720.00	73.00	Quistadrilus.multisetosus
2540.00	4460.00	83.00	Tanytarsus.sp.
2560.00	-9.00	91.00	Elliptio.complanata
2630.00	4345.00	61.00	Pisidium.variabile
2690.00	3430.00	52.00	Physella.gyrina
2690.00	3395.00	85.00	Tubifex.sp.
2740.00	5430.00	59.00	Pisidium.lilljeborgi
2812.00	-9.00	80.00	Stictochironomus.sp.
2820.00	5130.00	14.00	Chironomus.sp.
2850.00	-9.00	56.00	Pisidium.convertus
2860.00	-9.00	17.00	Coelotanypus.sp.
2920.00	5140.00	7.00	Aulodrilus.pluriseta
2950.00	4300.00	89.00	Valvata.tricarinata
3040.00	5720.00	58.00	Pisidium.henslowanum
3130.00	4165.00	10.00	Caenis.sp.
3150.00	4640.00	20.00	Cryptochironomus.sp.
3180.00	-9.00	25.00	Glossosoma.sp.
3200.00	4575.00	88.00	Valvata.sincera
3300.00	4300.00	70.00	Procladius.sp.
3350.00	4815.00	3.00	Amnicola.limosa
3420.00	-9.00	24.00	Glossiphonia.heteroclita
3500.00	5160.00	35.00	Limnodrilus.sp.
3500.00	-9.00	76.00	Sphaerium.nitidum
3600.00	-9.00	5.00	Aulodrilus.limnobius
3750.00	3990.00	27.00	Gyraulus.parvus
3750.00	-9.00	47.00	Parachironomus.sp.
3820.00	5265.00	77.00	Sphaerium.striatium
3830.00	5105.00	8.00	Bithynia.tentaculata
3900.00	-9.00	49.00	Paratendipes.sp.
3940.00	5095.00	93.00	Chironomus.plumosus
4200.00	4975.00	30.00	Hyalella.azteca
4300.00	5125.00	4.00	Asellus.sp.
4300.00	5100.00	21.00	Dicrotendipes.sp.
4750.00	5575.00	96.00	Helobdella.stagnalis
4830.00	4965.00	18.00	Cricotopus.sp.
4940.00	6540.00	26.00	Glyptotendipes.sp.
5100.00	5450.00	46.00	Oecetis.sp.
5550.00	-9.00	39.00	Microtendipes.sp.

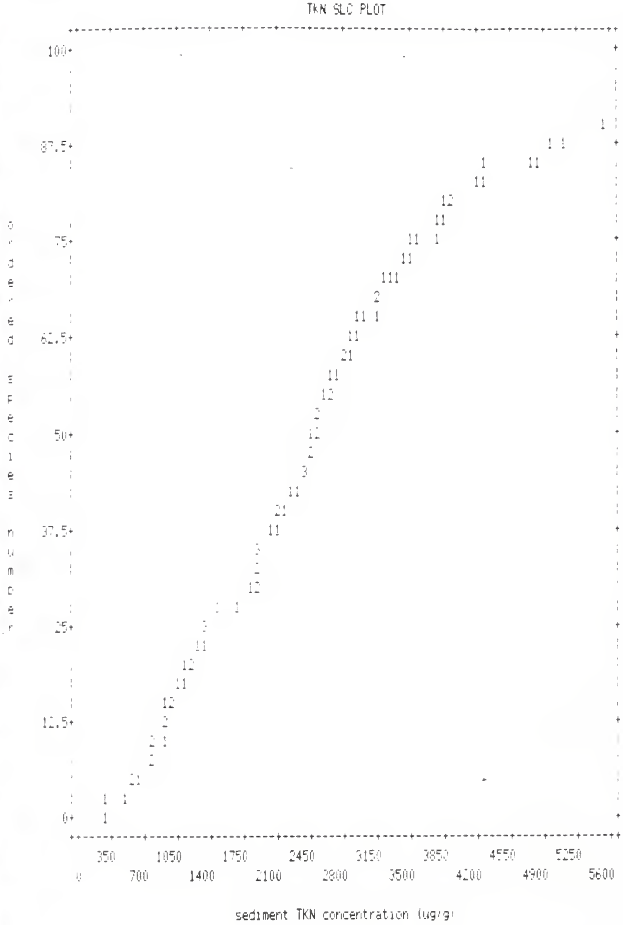


FIGURE E-34: SLC PLOT FOR TKN

TABLE **E**-35: Species SLC Values for
TP (ug/g)

P90	P95	SPNO	SPECIES
587.00	-9.00	9.00	Branchiura.sowerbyi
630.00	-9.00	11.00	Ceraclea.sp.
600.00	-9.00	22.00	Eukiefferiella.sp.
600.00	-9.00	37.00	Lumbriculus.variegatus
600.00	-9.00	40.00	Mystacides.sp.
600.00	-9.00	79.00	Stenonema.sp.
670.00	-9.00	97.00	Hexagenia.limbata
680.00	-9.00	44.00	Nanocladius.sp.
700.00	-9.00	32.00	Hydroptila.sp.
700.00	1100.00	62.00	Pleurocera.acuta
705.00	770.00	16.00	Cladotanytarsus.sp.
710.00	1400.00	81.00	Stylaria.lacustris
720.00	840.00	86.00	Turbellaria.sp.indet
740.00	-9.00	69.00	Pristina.osborni
760.00	1250.00	71.00	Prostoma.rubrum
799.00	-9.00	42.00	Nais.communis
852.00	1238.00	6.00	Aulodrilus.piqueti
858.00	-9.00	48.00	Paralauterborniella.sp.
880.00	1166.00	12.00	Chaetogaster.diaphanus
885.00	-9.00	74.00	Slavina.appendiculata
890.00	1100.00	43.00	Nais.variabilis
904.00	1068.00	31.00	Hydropsyche.sp.
918.00	2120.00	67.00	Potamothrix.vejdovskyi
940.00	1340.00	13.00	Cheumatopsyche.sp.
942.00	1438.00	84.00	Thienemannimyia.sp.
946.00	-9.00	28.00	Helisoma.anceps
980.00	1375.00	30.00	Hyalella.azteca
996.00	1415.00	52.00	Physella.gyrina
1000.00	1600.00	38.00	Manayunkia.speciosa
1008.00	1270.00	75.00	Specaria.josinae
1031.00	1510.00	53.00	Piguetiella.michiganensis
1049.00	1615.00	89.00	Valvata.tricarinata
1053.00	1400.00	83.00	Tanytarsus.sp.
1085.00	2142.50	10.00	Caenis.sp.
1100.00	1402.00	3.00	Amnicola.limosa
1100.00	1466.50	54.00	Pisidium.casertanum
1120.00	2000.00	7.00	Aulodrilus.pleuriseta
1132.00	-9.00	5.00	Aulodrilus.limnobius
1140.00	-9.00	33.00	Ilyodrilus.templetoni
1150.00	1400.00	90.00	Vejdovskyella.intermedia
1275.00	1775.00	88.00	Valvata.sincera
1290.00	1540.00	23.00	Gammarus.fasciatus
1294.00	3121.00	57.00	Pisidium.fallax
1308.00	-9.00	80.00	Stictochironomus.sp.
1330.00	-9.00	76.00	Sphaerium.nitidum
1359.00	1590.00	87.00	Uncinais.uncinata
1370.00	1590.00	27.00	Gyraulus.parvus
1385.00	1601.00	14.00	Chironomus.sp.
1398.00	1600.00	20.00	Cryptochironomus.sp.
1400.00	1700.00	21.00	Dicrotendipes.sp.
1400.00	1640.00	26.00	Glyptotendipes.sp.
1400.00	1820.00	55.00	Pisidium.compressum
1400.00	-9.00	60.00	Pisidium.nitidum
1400.00	1853.50	65.00	Pontoporeia.hoyi
1400.00	1707.00	78.00	Spirosperma.ferox
1400.00	2300.00	82.00	Stylodrilus.heringianus
1419.00	-9.00	15.00	Cladopelma.sp.
1420.00	-9.00	49.00	Paratendipes.sp.
1430.00	1730.00	8.00	Bithynia.tentaculata
1438.00	2204.00	73.00	Quistadrilus.multisetosus
1449.00	1800.00	4.00	Asellus.sp.
1473.00	1555.00	77.00	Sphaerium.striatium
1480.00	2090.00	59.00	Pisidium.lilljeborgi
1490.00	2260.00	92.00	Sphaerium.simile
1497.00	1854.00	34.00	Limnodrilus.hoffmeisteri
1500.00	3812.50	66.00	Potamothrix.moldaviensis
1505.00	-9.00	17.00	Coelotanypus.sp.
1520.00	-9.00	63.00	Polypedilum.scalaenum
1530.00	2300.00	61.00	Pisidium.variabile
1540.00	-9.00	24.00	Glossiphonia.heteroclita
1580.00	1880.00	64.00	Polypedilum.sp.
1615.00	-9.00	56.00	Pisidium.conventus
1616.00	2993.50	93.00	Chironomus.plumosus
1625.00	1830.00	70.00	Procladius.sp.
1670.00	-9.00	47.00	Parachironomus.sp.
1700.00	1800.00	46.00	Oecetis.sp.
1740.00	-9.00	29.00	Heterotrissocladius.sp.
1751.00	6629.50	36.00	Limnodrilus.udekemianus
1760.00	1800.00	96.00	Helobdella.stagnalis
1800.00	2775.00	35.00	Limnodrilus.sp.
1800.00	-9.00	39.00	Microtendipes.sp.
1930.00	2780.00	1.00	Ablabesmyia.sp.
1980.00	2955.00	85.00	Tubifex.sp.
2020.00	3120.00	50.00	Phaenopsectra.sp.
2020.00	5796.00	58.00	Pisidium.henslowanum
2060.00	-9.00	91.00	Elliptio.complanata
2310.00	3450.00	18.00	Cricotopus.sp.
2470.00	7502.50	100.00	Tubifex.tubifex
3440.00	-9.00	25.00	Glossosoma.sp.

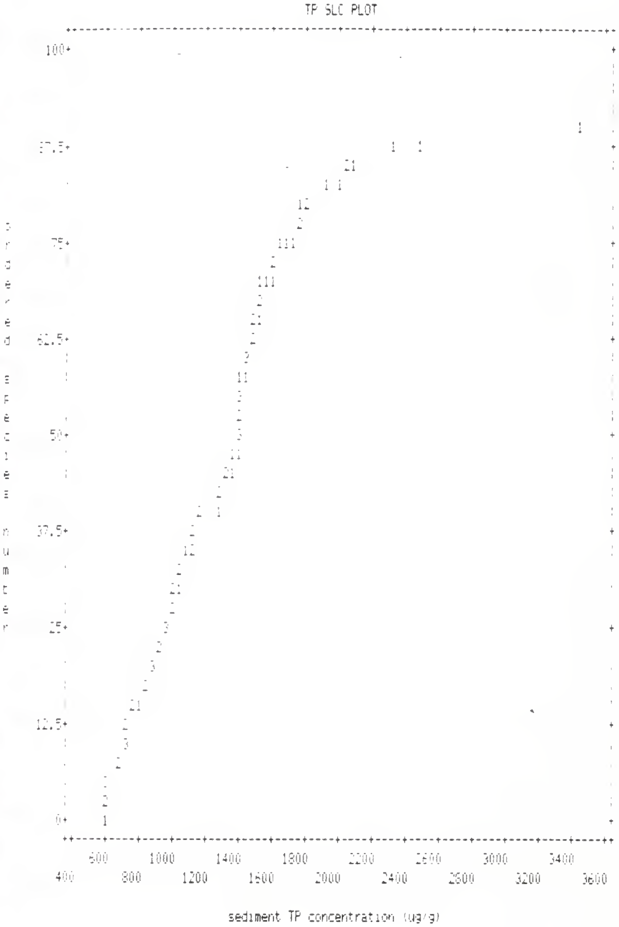


FIGURE E-35: SLC PLOT FOR TOTAL PHOSPHORUS

TABLE E-11: SCREENING LEVEL CONCENTRATION (SLC) VALUES CALCULATED FROM A COMBINED DATA SET (MOE + COE + OTHER)

	Screening Level Concentration			Existing Guideline (ug/g)		
Contaminant	Bulk (ug/g)	Normalized by TOC (ug/g C)	X 0.04 (ug/g)	MOE[1]	U.S. EPA Region V[2]	WDNR[3]
Arsenic	5.5**	713**	29	8	3	10
Chromium	25.6	4,022	161	25	25	100
Copper	16.4	2,546	102	25	25	100
Iron (%)	2.1	*	-	1	1.7	-
Lead	31.7	2,936	117	50	40	50
Manganese	464	27,743	1,110	-	30	-
Mercury	0.17	12.4	0.49	0.3	1	0.1
Nickel	15.0	2,288	92	25	20	100
Zinc	121.6	13,690	548	100	90	100
PCBs	0.127**	6.7**	0.27	0.05	10	0.05
Phosphorus	600	-	-	1,000	420	-
TKN	545	-	-	2,000	1,000	-
TOC (%)	1.0	-	-	-	-	-

[1] Open water dredge spoil disposal guidelines (Persaud and Wilkins, 1976).

[2] Guidelines for the pollutional classification of Great Lakes harbour sediments (U.S. EPA, 1977).

[3] Wisconsin Department of Natural Resources interim criteria and guidance criteria for in-water disposal of dredge materials (Sullivan *et al.*, 1985).

* TOC-normalized SLC for iron greater than g/g.

** Based on MOE In-Place Pollutants data TOC-normalized SLCs for arsenic and PCBs are 437 and 4.1 ug/g C, respectively. Bulk values are 5.5 and 0.029 ug/g, respectively.